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TRANSACTIONS

OF THE

KANSAS

ACADEMY OF SCIENCE.

VOL. XX, PART II.

CONTAINS

LIST OF OFFICERS, PAST AND PRESENT; MEMBERSHIP LIST JANUARY 1, 1907; SKETCH OF THE ACADEMY; CONSTITUTION AND BY-LAWS; MINUTES OF THIRTY-NINTH ANNUAL MEETING; PRESIDENT'S ADDRESS, AND SOME PAPERS READ.

DECEMBER, 1906.

STATE PRINTING OFFICE,
TOPEKA, 1907.
2826

TRANSACTIONS

OF THE

KANSAS

ACADEMY OF SCIENCE.

KANSAS ACADEMY OF SCIENCE.
CAPITOL BUILDING,
TOPEKA.

Compliments of

J. T. LOVEWELL,
Secretary.

ANNUAL MEETING, PRESIDENT'S ADDRESS,
AND SOME PAPERS READ.

DECEMBER, 1906.

STATE PRINTING OFFICE,
TOPEKA, 1907.
2825

TRANSACTIONS

OF THE

KANSAS

ACADEMY OF SCIENCE.

VOL. XX, PART II.

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OFFICERS OF THE ACADEMY, 1907.

President.....J. A. YATES.....Ottawa.
Vice-president.....E. HAWORTH.....Lawrence.
Vice-president.....F. B. DAINS.....Topeka.
Treasurer.....ALVA J. SMITH .....Emporia.
Secretary.....J. T. LOVEWELL .....Topeka.

Past Officers of the Academy.

PRESIDENTS.

1869, '70.... B. F. Mudge.
1871-'73.... John Fraser.
1874-'78.... F. H. Snow.
1879, '80.... B. F. Mudge.
1881, '82.... J. T. Lovewell.
1883..... A. H. Thompson.
1884, '85.... R. J. Brown.
1886..... E. L. Nichols.
1887..... J. D. Parker.
1888..... J. R. Mead.
1899..... T. H. Dinsmore, jr.
1890..... G. H. Failyer.
1891..... Robert Hay.
1892..... E. A. Popenoe.
1893..... E. H. S. Bailey.
1894..... L. E. Sayre.
1895..... Warren Knaus.
1896..... D. S. Kelly.
1897..... S. W. Williston.
1898..... D. E. Lantz.
1899..... E. B. Knerr.
1900..... A. S. Hitchcock.
1901..... E. Miller.
1902..... J. T. Willard.
1903..... J. C. Cooper.
1904..... Edward Bartow.
1905..... L. C. Wooster.
1906..... F. O. Marvin.

VICE-PRESIDENTS.

1869, '70.... J. S. Whitman.
1871..... B. F. Mudge.
1872, '73.... B. F. Mudge, Dr. R. J. Brown.
1874..... J. A. Banfield, J. D. Parker,
1875..... B. F. Mudge, J. D. Parker.
1876, '77.... B. F. Mudge.
1878..... B. F. Mudge, J. H. Carruth.
1879-'82.... J. H. Carruth, Joseph Savage.
1883..... J. R. Mead, G. E. Patrick.
1884..... F. H. Snow, Joseph Savage.
1885..... E. L. Nichols, G. H. Failyer.
1886..... J. D. Parker, N. S. Goss.
1887..... J. R. Mead, E. H. S. Bailey.
1888..... E. H. S. Bailey, T. H. Dinsmore, jr.
1889..... E. H. S. Bailey, G. H. Failyer.
1890..... D. S. Kelly, F. W. Cragin.
1891..... F. W. Cragin, O. C. Charlton.
1892..... F. O. Marvin, Mrs. N. S. Kedzie.
1893..... J. T. Willard, E. B. Knerr.
1894..... I. D. Graham, J. D. Hewitt.
1895..... I. D. Graham, S. W. Williston.
1896..... S. W. Williston, D. E. Lantz.
1896..... D. E. Lantz, A. S. Hitchcock.
1898..... C. S. Parmenter, L. C. Wooster.
1899..... A. S. Hitchcock, J. R. Mead.
1900..... E. Miller, J. C. Cooper.
1901..... J. C. Cooper, L. C. Wooster.
1902..... Edward Bartow, J. A. Yates.
1903..... Edward Bartow, J. A. Yates.
1904..... L. C. Wooster, B. F. Eyer.
1905..... F. W. Bushong, W. A. Harshbarger.
1906..... B. F. Eyer, J. E. Welin.

SECRETARIES.

1869-'73.... J. D. Parker,
1874, '75.... John Wherrell.
1876, '77.... Joseph Savage.
1878-'89.... E. A. Popenoe.
1890-'92.... E. H. S. Bailey.
1893..... A. M. Collette.
1894-'98.... E. B. Knerr.
1899-1901... D. E. Lantz.
1902-'04.... G. P. Grimsley.
1905, '06.... J. T. Lovewell.

TREASURERS.

1869-'73.... F. H. Snow.
1873-'75.... R. J. Brown.
1876, '77.... W. K. Kedzie.
1878-'83.... R. J. Brown.
1884, '85.... A. H. Thompson.
1886-'90.... I. D. Graham.
1891..... F. O. Marvin.
1892-'95.... D. S. Kelly.
1896..... L. E. Sayre.
1897-1900... J. W. Beede,
1901, '02.... E. C. Franklin.
1903-'06.... Alva J. Smith.

MEMBERSHIP OF THE ACADEMY,

January 1, 1907.

Dates in the following list signify date of election to membership in the Academy.

HONORARY MEMBERS.

G. P. Grimsley, Ph. D., 1904, asst. state geologist... Morgantown, W. Va.
Rev. Johns D. Parker, Ph. D., 1897..... New Haven, Conn.
Arnold B. Johnson, 1897, U. S. Lighthouse Board.... Washington, D. C.
W. A. Kellerman, Ph. D., 1897, Ohio State Univ..... Columbus, Ohio.
Edw. L. Nichols, Ph. D., 1897, Cornell Univ..... Ithaca, N. Y.
W. S. Franklin, Sc. D., 1897, Lehigh Univ..... South Bethlehem, Pa.
Geo. Wagner, Phar. D., 1904, Univ. of Wisconsin.... Madison, Wis.
S. W. Williston, Ph. D., 1902, Univ. of Chicago..... Chicago, Ill.

ASSOCIATE MEMBERS.

Mrs. R. J. Brown, 1903..... Leavenworth.
Mrs. Mary Savage, 1897..... Lawrence.

LIFE MEMBERS.

E. H. S. Bailey, Ph. D., 1883, Univ. of Kansas..... Lawrence.
J. C. Cooper, 1877, mineralogist..... Topeka.
F. W. Cragin, Ph. D., 1880..... Colorado Springs.
L. L. Dyche, M. S., 1881, Univ. of Kansas..... Lawrence.
Geo. H. Failyer, Ph. D., 1879, Dept. of Agr..... Washington, D. C.
E. C. Franklin, Ph. D., 1884, Stanford Univ..... Stanford Univ., Cal.
I. D. Graham, 1879, with *Kansas Farmer*..... Topeka.
Erasmus Haworth, Ph. D., 1882, Univ. of Kansas.... Lawrence.
Warren Knaus, M. S., 1884, editor..... McPherson.
D. E. Lantz, M. S., 1887, Biological Surv..... Washington, D. C.
J. T. Lovewell, Ph. D., 1878..... Topeka.
F. O. Marvin, C. E., 1884, Univ. of Kansas..... Lawrence.
J. R. Mead, 1879..... Wichita.
Ephraim Miller, Ph. D., 1873, Univ. of Kansas..... Lawrence.
E. A. Popenoe, A. M., 1872, Kansas Agr. Coll..... Manhattan.
L. E. Sayre, Ph. M., 1885, Univ. of Kansas..... Lawrence.
Alva J. Smith, 1903, county surveyor..... Emporia.
B. B. Smyth, 1880, curator Goss ornith. coll..... Topeka.
F. H. Snow, Ph. D., 1868, Univ. of Kansas..... Lawrence.
A. H. Thompson, D. D. S., 1873..... Topeka.
M. L. Ward, D. D., 1880, Ottawa Univ..... Ottawa.
J. T. Willard, M. S., 1883, Kansas Agr. Coll..... Manhattan.
S. W. Williston, Ph. D., 1880, Univ. of Chicago..... Chicago, Ill.

ANNUAL MEMBERS.

L. O. Adams, 1903, Univ. of Kansas..... Lawrence.
Orr Adams, 1898..... Tulluride, Colo.
Frank G. Agrelius, 1905..... Lawrence.
Wm. Aitkinhead, 1906, Washburn Coll..... Topeka.
H. C. Allen, 1904..... McPherson.
Carroll D. Armstrong, M. D., 1905..... Salina.
John J. Arthur, 1904 ..... Topeka.
C. H. Ashton, 1903, Univ. of Kansas ..... Lawrence.
Alfred W. Ayers, 1904, minister..... Onaga.
W. M. Bailey, 1906, teacher ..... Holton.
Harvey W. Baker, 1902, Kansas Agr. Coll..... Manhattan.
Elam Bartholemew, M. S., 1905 ..... Stockton.
Edward Bartow, Ph. D., 1897, State Water Surv..... Urbana, Ill.
W. J. Baumgartner, M. D., 1904, Univ. of Kansas... Lawrence.
Frank G. Bedell, 1904..... Iola.
J. W. Beede, Ph. D., 1894, Univ. of Indiana..... Bloomington, Ind.
F. W. Bushong, B. S., Univ. of Kansas ..... Lawrence.
H. P. Cady, 1904, Univ. of Kansas ..... Lawrence.
M. E. Canty, 1903 ..... Buffalo.
Charles I. Corp, 1905, Univ. of Kansas..... Lawrence.
Ewing N. Collett, 1903, Indian Univ..... Bacone, I. T.
Rev. John T. Copley, 1903..... Clinton.
R. W. Coppedge, 1905, teacher high school..... Topeka.
E. G. Corwine, 1905..... Mulvane.
W. R. Crane, 1904, Univ. of Kansas..... Lawrence.
Ralph K. Crawford, 1904, Univ. of Kansas..... Lawrence.
F. F. Crevecœur, 1899..... Onaga.
Robert W. Curtis, Ph. D., 1902, Univ. of Kansas .... Lawrence.
F. B. Dains, Ph. D., 1902, Washburn Coll..... Topeka.
Emil O. Deere, 1905, Bethany Coll..... Lindsborg.
S. D. Dice, 1904..... Alma.
James Dickson, 1904, Univ. of Kansas..... Lawrence.
Robert K. Duncan, 1906, Univ. of Kansas ..... Lawrence.
R. B. Dunlevy, B. S., 1896, Southwest Kan. Coll..... Winfield.
E. X. H. Dunmire, 1905, Univ. of Kansas ..... Lawrence.
Harry Eagle, 1905..... Topeka.
H. W. Emerson, 1904, Univ. of Kansas..... Lawrence.
B. F. Eyer, B. S., 1894, Kansas Agr. Coll..... Manhattan.
T. L. Eyerly, 1906..... Canadian, Tex.
W. F. Faragher, 1904, Univ. of Kansas ..... Lawrence.
Thomas B. Ford, 1905, Univ. of Kansas..... Lawrence.
Lillian E. Fowler, 1905, teacher high school..... Ottawa.
A. O. Garrett, 1901, teacher high school..... Salt Lake City, Utah.
Frank Gephart, 1906, Univ. of Kansas..... Lawrence.
Brice E. Hammers, 1904, chemist..... Topeka.
Dr. Eva Harding, 1904..... Topeka.
H. J. Harnly, B. S., 1903, McPherson Coll..... McPherson.
W. A. Harshbarger, B. S., 1900, Washburn Coll..... Topeka.
Frank Hartman, 1905..... Kansas City, Kan.

ANNUAL MEMBERS.

L. D. Havenhill, 1904, Univ. of Kansas ..... Lawrence.
Dr. Francis C. Herr, 1905 ..... Ottawa.
W. C. Hoad, 1904, Univ. of Kansas ..... Lawrence.
Gertrude E. Hole, 1906 ..... Manhattan.
George J. Hood, 1904, Univ. of Kansas ..... Lawrence.
H. A. Horton, 1906 ..... McPherson.
W. F. Hoyt, A. M., 1902, Wesleyan Univ. ..... Salina.
L. C. Hodson, 1905, Univ. of Kansas ..... Lawrence.
B. C. Hubbell, 1905 ..... Concordia.
Albert K. Hubbard, 1904, Univ. of Kansas ..... Lawrence.
Thomas M. Iden, 1897, State Norm. Sch ..... Emporia.
F. B. Isely, B. S., 1902, teacher high school ..... Wichita.
John J. Jewett, 1902 ..... Sawtelle, Cal.
A. W. Jones, B. S., 1894, Wesleyan Univ. ..... Salina.
George F. Kay, 1904, Univ. of Kansas ..... Lawrence.
W. H. Keller, 1898, teacher high school ..... Effingham.
Leslie A. Kenoyer, 1906 ..... Independence.
Harry L. Kent, 1904, State Norm. Sch ..... Hays.
John H. Klopfer, 1904 ..... Topeka.
Pierce Larkin, 1902, high school ..... Helena, Okla.
B. E. Lewis, 1904, teacher city schools ..... Eureka.
M. A. Low, 1906, attorney ..... Topeka.
C. H. Lyon, 1900, teacher high school ..... Emporia.
Hester E. Loveall, 1904, manual tr. sch ..... Kansas City, Mo.
H. T. Martin, 1902, Univ. of Kansas ..... Lawrence.
R. Matthews, D. D. S., 1898 ..... Wichita.
C. E. McClung, 1903, Univ. of Kansas ..... Lawrence.
D. F. McFarland, 1903, Univ. of Kansas ..... Lawrence.
J. M. McWharf, M. D., 1902 ..... Ottawa.
W. G. Medcraft, 1904, Wesleyan Univ ..... Salina.
Grace R. Meeker, 1899 ..... Ottawa.
C. F. Menninger, M. D., 1903 ..... Topeka.
H. L. Miller, 1904, high school ..... Topeka.
W. L. Moodie, 1906, Univ. of Kansas ..... Lawrence.
Travis Morse, 1903 ..... Iola.
J. H. Newby, 1899 ..... Osage City.
N. P. Nielsen, 1906, architect ..... Topeka.
A. M. Nissen, A. M., 1888, teacher high school ..... Wetmore.
Henry N. Olson, 1905, Bethany Coll ..... Lindsborg.
Frank Patrick, 1903 ..... Topeka.
Leslie F. Paull, 1903, manual tr. sch ..... Kansas City, Mo.
L. M. Peace, 1904, Univ. of Kansas ..... Lawrence.
Arthur D. Pitcher, 1906, Univ. of Kansas ..... Lawrence.
Norman Plass, D. D., 1902, president Washburn Coll. . Topeka.
M. A. Pond, 1906, teacher ..... Topeka.
L. M. Powell, M. D., 1906 ..... Topeka.
Charles H. Popenoe, 1903, Kansas Agr. Coll. ..... Manhattan.
C. S. Prosser, M. S., 1892, Ohio State Univ. ..... Columbus, Ohio.
W. S. Prout, 1904 ..... Topeka.

ANNUAL MEMBERS.

Albert B. Reagan, 1904, Indian School..... Mora, Wash.
W. F. Rice, 1902 ..... Gordon.
W. B. Robertson, 1905, Univ. of Kansas..... Lawrence.
A. P. Ruediger, 1905 ..... Lawrence.
W. G. Russell, 1905 ..... Russell.
D. C. Schaffner, 1903, Coll. of Emporia..... Emporia.
J. H. Schaffner, A. M., M. S., 1902, Univ. of Ohio.... Columbus, Ohio.
Theo. H. Scheffer, 1903..... Emporia.
Eva Schley, 1903, teacher high school..... Topeka.
Aaron Schuyler, 1904, Wesleyan Univ..... Salina.
C. H. Shattuck, 1899, Washburn Coll..... Topeka.
Roscoe H. Shaw, 1904, Univ. of Missouri..... Columbia, Mo.
Miriam Sheldon, 1906, Bethany Coll..... Topeka.
E. T. Shelley, M. D., 1902 ..... Atchison.
Claude J. Shirk, 1905, McPherson Coll..... McPherson.
J. A. G. Shirk, 1904, Ottawa Univ..... Ottawa.
Paul L. Shuey, 1905, Univ. of Kansas..... Lawrence.
Ralph C. Shuey, 1905, Univ. of Kansas..... Lawrence.
Eugene G. Smyth, 1901, Univ. of Chicago..... Chicago, Ill.
Mrs. Lumina R. Smyth, M. S., 1902 ..... Topeka.
W. N. Speckman, Ph. D., 1903, Wesleyan Univ. ..... Salina.
William O. Starin, 1906, Univ. of Kansas..... Lawrence.
B. T. Stauber, D. D., 1903 ..... Salina.
S. G. Stewart, M. D., 1904..... Topeka.
Chas. M. Sterling, 1904, Univ. of Kansas..... Lawrence.
Chas. H. Sternberg, 1895, explorer and collector..... Lawrence.
Teresa Stevenson, 1901..... Ottawa.
E. F. Stimpson, 1904, Univ. of Kansas..... Lawrence.
A. J. Stout, 1904, teacher high school..... Topeka.
Frank Strong, Ph. D., 1905, chancellor Kansas Univ., Lawrence.
Olin Templin, 1904, Univ. of Kansas..... Lawrence.
F. J. Titt, B. S., 1898, Kingfisher Coll..... Kingfisher, Okla.
E. S. Tucker, 1904, Univ. of Kansas..... Lawrence.
J. D. Walters, M. S., 1894, Kansas Agr. Coll..... Manhattan.
C. D. Weaver, M. D., 1902..... McPherson.
Ella Weeks, 1903, Kansas Agr. Coll..... Manhattan.
J. E. Welin, 1899, Bethany Coll..... Lindsborg.
Archie J. Werth, 1906, Univ. of Kansas..... Lawrence.
C. H. Withington, 1903, Kansas Agr. Coll..... Manhattan.
H. I. Woods, M. S., 1902, Washburn Coll..... Topeka.
L. C. Wooster, Ph. D., 1897, State Norm. Sch..... Emporia.
J. A. Yates, M. S., 1897, Ottawa Univ ..... Ottawa.

Total number of members, January 1, 1907, 173.

MINUTES.

Thirty-ninth Annual Meeting, Kansas Academy of Science, November 29, 30, and December 1, 1906.

TOPEKA, KAN., November 29, 1906.

BY appointment of the executive committee, the Kansas Academy of Science met at its rooms, and was opened at eight P. M., with the president, F. O. Marvin, in the chair. About twenty-five members were present. By adjustment of the museum tables it was found that this room gave ample space for the meeting and was altogether convenient and commodious.

TREASURER'S REPORT.

Reports of officers being called for, the treasurer presented the following:

ACCOUNT OF THE TREASURER OF THE KANSAS ACADEMY OF SCIENCE TO NOVEMBER 29, 1906.

Receipts.

Balance on hand from last year	$488 23
Fees and dues	132 70
Sale of Transactions	12 99
Total	$633 83

Expenditures.

December 14, 1905.	To typewriting programs	$1 25
February 6, 1906.	Reprinting volume IV	78 20
March 20, 1906.	Illustrations	5 50
March 20, "	Subscription, *Journal of Geology*	3 50
March 20, "	Express	1 00
March 20, "	Reprinting volume V	88 55
April 18, "	Reprinting volume VI	108 10
July 20, "	Reprinting volume VII	157 00
December 3, 1905.	Placed on time deposit	250 00
Total		$693 10

November 29, 1906, balance due treasurer, $59.27.

On motion, this report was referred to W. A. Harshbarger, as auditor, and found correct. Approved.

SECRETARY'S REPORT.

The secretary is pleased to chronicle another year of progress for the Academy. We are now fairly entered on the era of annual volumes of our Transactions, and our colleagues will have the encouragement of publishing at an early date whatever contributions they may make to scientific discovery. We can do this because it is of mutual convenience to the state printer and to the Academy, and no one will object so long as this plan does not increase the expense to the state. A certain annual appropriation is now admitted as reasonable, and with the growth of the state and its institutions, the Academy may expect to share recognition according to its merit. It is of course expected that in biennial years the legislative printing will take the precedence in the state printing-office, and in order to have early publication in such years, our Transactions must be in hands of the printer before the legislative rush begins. Past experience shows that delays are most likely to come from neglect of members to get their papers ready for the press; and to secure the results now aimed at, the papers ought after being read at the annual meeting, to be placed at once in the hands of the secretary for publication. The time may come when our Transactions will be issued as quarterly bulletins and so save a considerable item of expense on their distribution by mail. Following the custom of past years, the secretary issued an announcement in the summer of the coming annual meeting, and this is sent to all members and to others who may be stimulated to joining in our work.

THE MUSEUM.

Care of the museum is part of the secretary's duty. The ability and good fortune of my predecessor, Doctor Grimsley, enabled him to lay the foundation of a very useful economic museum for our state. This must be enlarged and improved till we can show the forms and distribution of our mineral wealth. As this museum had its inception in the St. Louis Exposition, so the coming Kansas semicentenial ought to bring it to perfection. It will be for the Academy to guide in this development, and there is no way in which we may expect more cordial cooperation or in which we may be more useful to the state. This is one of the ways in which we may show ourselves worthy of being a "coordinate branch of the State Board of Agriculture."

THE LIBRARY.

The growth of our library is an illustration of the comity and universality of science. In this realm there are no state lines, no political divisions. Our fellow workers, whether in Australia, St. Petersburg, or Peru, are ready to share with us in their discussions and to rejoice in our discoveries. So from the beginning of our history we have found other scientific bodies, all over the world, ready to exchange with us their publications, even when our members were few and our Transactions only filled a small pamphlet. In these exchanges we have been conscious of getting the better end of the trade, and our older sister societies have shown their sympathy in being willing to accept our productions and wait for us to grow to something better. We have grown, and our late volumes make a respectable showing as compared with others of their class. Reprints of the first seven volumes enable us to exchange complete sets of the first twenty volumes, and we can, with some assurance, offer these for the valuable works coming to us from other societies.

ACCESSIONS.

During the past year we have received not less than 500 unbound volumes, pamphlets, and parts of volumes, which are filed away and await the time for binding. Several hundred volumes are now in a greater or lesser state of completeness, and in some cases missing numbers will be difficult to secure. Some of them may be purchased, but it will require much correspondence, and will be impossible always to get complete *sets*, though we may have complete volumes.

Over fifty bound volumes have come to us during the year, the larger portion of these being from the Smithsonian, and other government departments in Washington. Many of these are of great value, bulky, finely illustrated, and would be a valuable acquisition for any library.

Our library has a good many volumes in foreign languages, which will interest only a small number of our members, but it is important to have one collection in the state where these foreign books may be consulted.

In government publications like those of the Smithsonian, of the Geological Survey, and of the Agricultural Department, our files are duplicated, both in the State Library and in the State Historical Society. The latter has the most complete collection found in our state-house of these books.

CATALOGUING.

The usefulness of a library depends largely on a convenient catalogue. In the Transactions, from volume X *et seq.*, much space has been given to the librarian's reports, wherein catalogues and lists of accessions to the library have been published. The library contains a card catalogue, where the volumes are grouped by countries and by titles. From our Transactions, volumes XIV to XVIII, inclusive, in the librarian's reports, may be found a record which gives substantially the contents of our library. There is also an authors' card catalogue and a subject card catalogue, on which considerable time has been spent. To complete these according to modern library standards, with cross-references, etc., will require much labor as well as skill. Before undertaking any very complete system of cataloguing, it may be well to consider our connection with other libraries and book collections in the state-house, and see whether a common union and management of these is not feasible. Needless duplication of books could be avoided, expense of binding saved, and, more important than all, a single and complete catalogue might be kept where it could be found, if any desired volume was available anywhere in the state-house.

PURCHASE OF NEW BOOKS.

Funds available for buying new books have been applied this year to reprinting volumes IV to VII of our Transactions. Money will be further needed to secure missing numbers in the volumes of exchanges above alluded to, and it is desirable to have our material bound as early as possible. From membership fees and dues a small income is assured which may be applied to the library and to other Academy work.

After report of the treasurer and secretary, President Marvin named the following committees:

On nominations: Willard, Wooster, and Cady.

On resolutions: Knaus, Bailey, and Yates.

On program: Sayre and Harshbarger.

On necrology: Thompson, Sternberg, and McWharf.

On publication: The retiring president, the secretary, and one member from Topeka—in this instance, Professor Dains.

On membership: Cooper, Harshbarger, and Miss Meeker.

On time and place for next meeting: Welin, Shattuck, and Smith.

There being time, on motion the Academy next listened to a paper by Prof. L. E. Sayre, numbered 2 on the program, entitled, "Drug Standards with Reference to the Pure Food and Drug Law."

The meeting adjourned to meet to-morrow morning at nine o'clock.

ACADEMY ROOMS, Friday, nine A. M.

President Marvin announced the committee on library, as follows: Professors Shattuck, Kay, and Wilm.

The committee on membership reported the following applications to become members of the Academy:

Wm. Leslie Moodie, laboratory assistant in biology, Kansas University, Lawrence.

Robert Kennedy Duncan, professor of industrial chemistry, Kansas University, Lawrence.

Archie J. Werth, assistant chemist State Water Survey, Lawrence.

Arthur D. Pitcher, instructor mathematics, Kansas University, Lawrence.

E. C. Wilm, teacher in Washburn College, Topeka.

Wm. Aitkinhead, teacher in Washburn College, Topeka.

Frank Gephart, fellow in chemistry, Kansas University, Lawrence.

Wm. O. Starin, fellow in biology, Kansas University, Lawrence.

Leslie A. Kenoyer, student, Independence.

M. A. Low, general attorney Chicago, Rock Island & Pacific railway, Topeka.

T. L. Eyerly, science teacher, Canadian, Tex.

L. M. Powell, M. D., physician and surgeon, Topeka.

Gertrude E. Hole, teacher, Manhattan.

M. A. Pond, teacher of penmanship, Topeka.

Miriam Sheldon, teacher of science, College of the Sisters of Bethany, Topeka.

W. M. Bailey, teacher natural science, Holton.

H. A. Horton, student in botany, McPherson.

On motion, it was voted that the rules be suspended, and the secretary was instructed to cast the ballot of the Academy for the persons named in this report. The ballot was duly cast, and they were accepted as members of the Academy on complying with the condition of fees and enrolment.

The Academy divided into sections and resumed the reading of papers, as announced on the published program.

SECTION A.

B. F. Eyer, chairman; J. A. Yates, secretary.

No. 1. Dances of the Jemez Pueblo Indians (by title), Albert B. Reagan.

No. 3. Modulus of lunar influence—not in lifting but in falling movement (by title), J. J. Jewett.

No. 4. A most wonderful tool, John H. Klopfer.

No. 5. Harmonic forms—plane forms (second paper), B. B. Smyth.

No. 6. The form and dimensions of the earth, H. I. Woods.

No. 7. On the composition of Kansas oil, F. W. Bushong.

No. 8. The quantitative estimation of iron and cobalt by the rotating cathode, R. W. Curtis and S. A. McReynolds.

No. 9. On the formation of azo compounds, F. B. Dains.

No. 10. On the precipitation of potassium ferrocyanide in the presence of ammonium salts, F. B. Dains.

No. 11. Method of analysis for pharmaceutical preparations (by title), L. D. Havenhill.

No. 12. Method for the detection of small quantities of benzine in gases (by title), W. F. Faragher.

No. 13. The pharmaceutical industry of America (by title), H. W. Emerson.

No. 17. Short methods for drug assay (by title), H.W. Emerson.

No. 49. A test for artificial bleaching of flour (by title), J. T. Willard.

No. 51. The capacity of a condenser as a function of time, as found by the method of direct discharge as well as by alternating currents (by title), Bruce V. Hill.

No. 37. Nature photography in Kansas—the work of Mr. and Miss McColm, Grace R. Meeker.

Voted that the privileges of the floor be extended to all visitors.

Adjourned, to meet in general session in the manual training high school hall, at two o'clock P. M.

SECTION B.

J. E. Welin, chairman; W. A. Harshbarger, secretary.

The section met in the library of the Academy, and the following program was presented:

No. 18. Some geological studies on northwestern Washington, and adjacent British territory (by title), Albert B. Reagan.

No. 19. Development of forest belts in the northwestern part of of Clay county, Kansas (by title), John H. Schaffner.

No. 20. An adequate cause for extremes of climate in geological periods (by title), J. J. Jewett.

No. 21. Records of desultory collecting in Kansas and Colorado (by title), E. S. Tucker.

No. 22. Contributions towards a catalogue of insects in Kansas (by title), E. S. Tucker.

No. 23. Corrections and additions to the list of Kansas mammals (by title), D. E. Lantz.

No. 24. Remarks on the bird fauna of Kansas (by title), D. E. Lantz.

No. 25. Catalogue and key of the Kansas flora (by title), Bernard B. and Lumina Riddle Smyth, and John H. Schaffner.

No. 26. Food habits of our Kansas lizards and batrachians (by title), F. A. Hartman.

No. 27. A list of hymenoptera collected in Arizona in 1902, 1903, 1904, 1905 and 1906 by the Kansas entomological expeditions, F. H. Snow.

No. 28. Recent additions to the bird fauna of Kansas, F. H. Snow.

No. 29. Soil bacteria (by title), L. C. Wooster.

No. 45. Additions to the list of Kansas coleoptera for 1906, W. Knaus.

No. 46. Sacramento mountains, New Mexico, coleoptera, W. Knaus.

No. 47. Notes on Kansas coleoptera, W. Knaus.

No. 48. Kansas Carabidæ, Cerambycidæ, and Chrysomelidæ, W. Knaus.

Many of these papers were read by title and others by abstracts, so that not much time was consumed, and session was adjourned to meet with section A.

GENERAL SESSION, FRIDAY, NOVEMBER 30.

MANUAL TRAINING HALL, two P. M.

No. 30. Preliminary announcement of a serial catalogue of periodicals, transactions, etc., found in the Academy of Science, Washburn College and state libraries, F. B. Dains.

No. 31. Some tests of Kansas road metals, F. O. Marvin.

No. 32. Kansas climatology, T. B. Jennings.

No. 33. The spectrum and spectrum scales, J. T. Lovewell.

No. 34. Is the Gila monster (*Heloderma suspecta* Cope) a venomous reptile? F. H. Snow.

No. 35. Heredity in stock-breeding, I. D. Graham.

No. 36. Nomenclature of the Kansas Coal Measures (by title), E. Haworth and J. Bennett.

No. 38. The composition of ice-cream, Frank Gephart and E. H. S. Bailey.

No. 39. Some animals I have discovered in the fossil beds of Kansas, Charles H. Sternberg.

No. 40. Some results of the entomological expedition to Arizona in June and July, 1906, F. H. Snow.

No. 41. Coffee—analysis of different qualities, L. E. Sayre.

No. 50. Noise—its relation to health, disease, and longevity, J. M. McWharf.

No. 52. The measurement and comparison of sound intensities (by title), Bruce V. Hill.

Presidential address, recent movements in engineering, F. O. Marvin.

At the close of this address it was voted to hold the next general session at nine A. M. December 1, at Washburn observatory. The session adjourned for a banquet tendered by the local members at the Y. W. C. A. rooms.

BANQUET.

For many years it has been customary for the members to break bread together at least once during the annual session, and these occasions help to knit closer our comradeship. The tables on this occasion were made cheery with floral decorations, and a neat menu, interspersed with appropriate and suggestive quotations, gave piquancy to the nicely served viands.

Dr. A. H. Thompson acted as toastmaster, and in the post-prandial program gracefully introduced the speakers who had been chosen to enliven the feast and enable members for the moment to unbend from serious work. A poem by Mrs. Joseph Savage, one of our earliest members, was read, and received with cordial applause.

J. C. Cooper gave the address of welcome on behalf of the local committee, and the following gentlemen responded to toasts with great acceptance: F. O. Marvin, B. F. Eyer, J. E. Welin, L. E. Sayre, J. I. McWharf, Warren Knaus, F. H. Snow, and B. B. Smyth.

GENERAL SESSION, DECEMBER 1, 1906.

WASHBURN OBSERVATORY, nine A. M.

The committee on place and time of meeting reported as follows:

That the annual meeting of the Academy for 1907 be held in the city of Emporia; the time is to be left in the hands of the executive committee.

J. E. WELIN,
C. H. SHATTUCK,
ALVA J. SMITH,
Committee.

Report approved. The committee on nomination of officers reported their nomination for—

President, J. A. Yates, Ottawa.
Vice-president, E. Haworth, Lawrence.
Vice-president, F. B. Dains, Topeka.
Secretary, J. T. Lovewell, Topeka.
Treasurer, A. J. Smith, Emporia.

On motion, the rules were suspended, and J. C. Cooper cast the ballot of the Academy for the candidates named by the committee for officers and they were declared duly elected.

On motion, J. C. Cooper was granted life membership, on complying with conditions relating to dues, if there be any in his case.

It was voted that back volumes of the Transactions be furnished to members at one-half the published list price.

Voted that the committee on publication be instructed to publish "separates" or reprints, when these are desired by authors of papers, provided that the financial end of the proposition be made satisfactory.

Reading of papers was continued, as follows:

No. 44. Structure and classification of wood found in the moraines of Jackson county, C. H. Shattuck.

No. 43. Some notes on the origin of heterospory, as shown in cultures of *Marsilea* (illustrated by the reflectoscope), C. H. Shattuck.

No. 42. The accuracy of a modern balance and set of weights, H. I. Woods and Alice K. McFarland.

On motion, the secretary was instructed to send greetings and programs to J. R. Mead, L. C. Wooster, and Mrs. Joseph Savage.

RESOLUTIONS.

The committee on resolutions reported:

Resolved, That the thanks of the Academy of Science are due the local members of the Academy and their friends, for the agreeable banquet and reception so generously tendered.

Resolved, That we appreciate the favor shown us by the papers of Topeka, in their report of our daily proceedings, and thank them for their courtesy.

Resolved, That we thank the faculty of Washburn College and the Topeka board of education, for the facilities afforded us in holding our meetings.

W. KNAUS,
E. H. S. BAILEY,
J. A. YATES,
Committee.

On motion, the Academy adjourned *sine die.*

HISTORICAL SKETCH.

THE organization of a Kansas association of scientific men at an early date was due to the efforts of Rev. Johns D. Parker and Prof. B. F. Mudge, who, in July, 1868, issued a call signed by seventeen men for a meeting of all persons in the state interested in natural sciences to meet in Topeka.

The first meeting was held in September of that year, in Lincoln College (now Washburn), and the Kansas Natural History Society was organized and officers elected. The object, as stated in the original draft of the constitution, "shall be to increase and diffuse a knowledge of the natural sciences, particularly in relation to the state of Kansas." At the fourth annual meeting, held in Leavenworth, in 1871, the name was changed to the Kansas Academy of Science. In 1873 the Academy became a coordinate department of the State Board of Agriculture by the terms of the following act of the legislature:

"The Academy of Science shall be a coordinate department of the State Board of Agriculture, with their office in the agricultural rooms, where they shall place and keep for public inspection the geological, botanical and other specimens, the same to be under the direction and control of the officers of the said Academy of Science. An annual report of the transactions of said Academy of Science shall be made on or before the 15th day of November of each year to the State Board of Agriculture, for publication in the annual Transactions of said board.

The Academy has increased in membership from the original small body of scientists to over 200. It has held thirty-nine annual meetings, of which nineteen have been held in Topeka, six in Lawrence, four in Manhattan, two in Leavenworth, two in Emporia, and one each in Atchison, Baldwin, Iola, McPherson, Ottawa, and Wichita.

Twenty volumes of the Transactions have been published, varying in size from a few pages in the early numbers to 350 pages in the later volumes. These publications contain many papers of recognized scientific value. The exchange list includes over 500 names of societies and libraries.

The Academy is now installed in the west wing of the capitol

building, at Topeka, in rooms on the ground floor. It has three connecting rooms, used for office, library, and museum.

The museum has been greatly increased by the gift of the state mineral display erected at the St. Louis Exposition, and given suitable cases to hold this large amount of material. It thus has the finest economic collection of the Kansas mineral industries in the state—an exhibit which received two gold medals, twenty-two silver medals, and fourteen bronze medals.

CONSTITUTION.

SECTION 1. This association shall be called the Kansas Academy of Science.

SEC. 2. The objects of this Academy shall be to increase and diffuse knowledge in the various departments of science.

SEC. 3. Members of this Academy shall consist of two classes, active and honorary (including associate). *Active members* may be annual or life members. *Annual members* may be elected at any meeting of the Academy, and shall sign the constitution and pay a fee of one dollar and annual dues of one dollar; but the secretary and treasurer shall be exempt from the payment of dues during the years of their service. Any person who shall at one time contribute twenty dollars to the funds of this Acadamy may be elected a *life member* of the Academy, free of assessment. Any member who has paid dues to the Academy for ten consecutive years, or who has been legally exempt during any portion of that time, may be elected a *life member* on the payment of ten dollars. Any member who has been a member of this Academy in good standing for twenty years may be elected a *life member* without payment of further fees or dues. *Honorary members* may be elected on account of special prominence in science, on the written recommendation of two members of the Academy. In any case, a two-thirds vote of members present shall elect to membership. Applications for membership in any of the foregoing classes shall be referred to a committee on applications for membership, who shall consider such application and report to the Academy before the election.

SEC. 4. The officers of this Academy shall be chosen by ballot at the annual meeting, and shall consist of a president, two vice-presidents, a secretary, and a treasurer, who shall perform the duties usually pertaining to their respective offices. The president, secretary and treasurer shall constitute an executive committee. The secretary shall have charge of all the books, collections and material property belonging to the Academy.

SEC. 5. Unless otherwise directed by the Academy, the annual meeting shall be held at such time and place as the executive com-

mittee shall designate. Other meetings may be called at the discretion of the executive committee.

SEC. 6. This constitution may be altered or amended at any annual meeting, by a vote of three-fourths of attending members of at least one year's standing. No question of amendment shall be decided on the day of its presentation.

BY-LAWS.

I. The first hour, or such part thereof as shall be necessary, in each session, shall be set aside for the transaction of the business of the Academy. The following order of business shall be observed, as far as practicable:

1. Opening.
2. Reports of officers.
3. Reports of standing committees.
4. Appointment of special committees.
5. Unfinished business.
6. New business.
7. Reports of special committees.
8. Election of officers.
9. Election of members.
10. Program.
11. Adjournment.

II. The president shall deliver a public address on the evening of one of the days of the meeting, at the expiration of his term of office.

III. No meeting of this Academy shall be held without a notice of the same having been published in the papers of the state at least thirty days previous.

IV. No bill against the Academy shall be paid by the treasurer without an order signed by the president and secretary.

V. Members who shall allow their dues to remain unpaid for two years, having been annually notified of their arrearage by the treasurer, shall have their names stricken from the roll.

VI. The secretary shall have charge of the distribution, sale and exchange of the published Transactions of the Academy, under such restrictions as may be imposed by the executive committee.

VII. Eight members shall constitute a quorum for the transaction of business.

VIII. The time allotted to the presentation of a single paper shall not exceed fifteen minutes.

IX. No paper shall be entitled to a place on the program unless the manuscript, or an abstract of the same, shall have been previously delivered to the secretary.

PRESIDENT'S ADDRESS.

"Recent Growth of Engineering Colleges."

By F. O. Marvin, Dean of the School of Engineering, University of Kansas.

RECENT GROWTH OF ENGINEERING COLLEGES.

By F. O. Marvin, University of Kansas.

Presidential address, delivered at Topeka, November 30, 1906, before the thirty-ninth annual meeting of the Kansas Academy of Science.

IN looking over the field of recent engineering operations for indications of growth and unusual activity, far too much is discovered to warrant a simple notice even of all that is found.

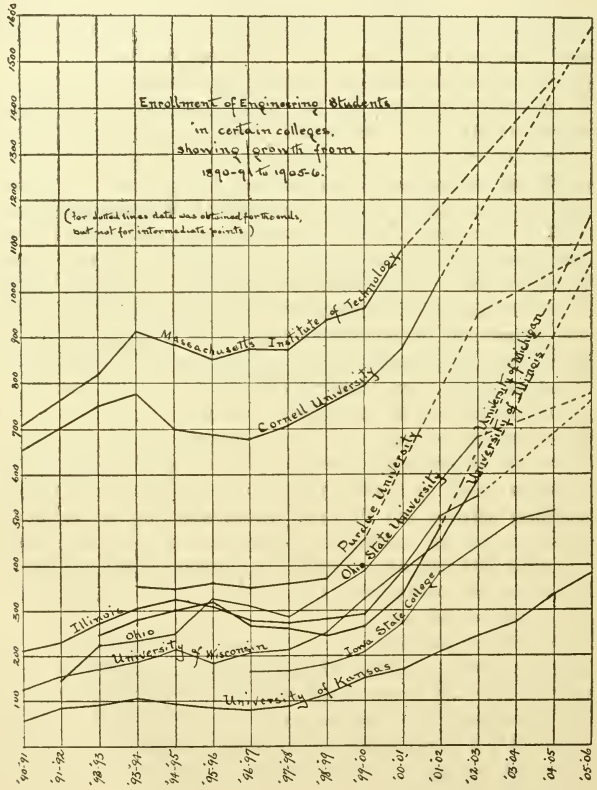
There are the great transcontinental lines, some new ones being built and others projected, and the double tracking and other improvement of old ones. There is the trend toward the substitution of electricity for steam locomotion, especially for service at terminals, and the development of interurban electric lines. The steam turbine has many achievements to its credit. The alternating current has been harnessed. Bridge and building construction is being revolutionized by the combination of concrete and steel, a matter made possible by a revolution in the methods of making Portland cement; a revolution so important for America that we are likely to wrest supremacy in the cement industry from Europe, as we not long ago forced her to yield her first place in steel. We are ushering in a cement age, as we then created a steel age. The gas-engine has come into prominence as a prime mover.

These and many others are great and interesting movements; yet the writer of this paper, being a teacher of engineering, and on this occasion speaking to a body of scientific people, most of whom are teaching science and its applications affecting the welfare of mankind, has chosen to turn to another great movement in which he has some part and about which he has some first-hand knowledge, and which, furthermore, lies beneath other movements as a basic or fundamental one.

To the teacher, indeed to every wide-awake and patriotic citizen, education is always an interesting and ever perennial topic, and to scientific people the recent rapid growth and development of the colleges of engineering in our land can but be of especial interest. This subject is a large and inexhaustible one, and only some phases of it can be discussed with any degree of adequacy within the limits of a brief address.

The report of the United States commissioner of education for the year 1899–1900 gives a total enrolment of students in universities, colleges, and schools of technology, exclusive of students in the pro-

fessional courses, of 98,923, of which number 11,874 were in engineering or architectural courses. The report for the year 1903–'04 gives, as corresponding figures, 118,816 for the total attendance and 21,087 for the engineers and architects. In these four years the increase in the total number of students attending college is 20.1 per cent., while for the technical students the increase amounts to 77.6 per cent., nearly four times as great a rate.



A study of the enrolment in a few of the prominent engineering colleges brings out certain general features common to all, as well as some differences. These institutions were chosen to represent different sections geographically, and which would therefore repre-

sent somewhat different surrounding conditions. They are the Massachusetts Institute of Technology, Cornell University, Purdue University, Ohio State University, University of Michigan, University of Wisconsin, University of Illinois, the Iowa State College, and the University of Kansas. The statistics given refer only to technical students, and the changes are shown graphically in the accompanying plate, for a part of which credit should be given to Prof. A. N. Talbot, of the University of Illinois, his diagram being extended and brought down to date. Beginning with the year 1890–'91, enrolments in all colleges show an increase up to 1894 or 1895 and then either a falling-off or practically a maintenance of numbers. This was due, no doubt, to the financial depression in the early '90's, which put a stop to so many public enterprises, lessening the demand for young engineers on the one hand and making their parents feel a monetary stringency on the other. But in the late '90's the schools began to feel the effects of the upward wave of prosperity, and their enrolments began to increase with a sharp rise about the year 1899–1900, the older Eastern schools taking the upward trend a year or two earlier. Since the beginning of the present century the rate of increase has been very remarkable, if not phenomenal, as is shown by the diagram, or by the subjoined table, covering the six years from 1899–1900 to and including 1905–'06.

GROWTH OF ENROLMENTS OF ENGINEERING STUDENTS IN CERTAIN COLLEGES.

Years 1899–1900 to 1905–'06.

COLLEGE.	Period beginning 1899–1900.	Per cent. of increase.	Average rate per year.	Enrolment last year.	Seniors in last year of period.
Mass. Inst. Technology	5 years.	52	10.4%	1,466	243
Cornell University	6 "	99	16.5	1,582	250
Purdue University	6 "	136	22.6	1,087	187
Ohio State University	6 "	99	16.5	787	73
University of Illinois	6 "	257	42.8	1,064	143
University of Wisconsin	6 "	136	22.6	768	113
University of Michigan	6 "	339	56.5	1,164	119
University of Kansas	6 "	153	25.5	379	33
Iowa State College	5 "	151	30.2	515	78

The percentages of increase in the case of the two Eastern colleges are relatively low, notwithstanding their rapid growth, because they already possessed large enrolments at the beginning of the period. They were also well equipped. The most remarkable expansion in numbers occurred with the group of institutions lying in the Mississippi valley. These found themselves placed under a

severe stress to provide for the instructional force and the equipment in buildings, laboratories and apparatus needed to properly care for thê influx of students into engineering courses.

The growth of the Western schools has not been so spectacular, but has been none the less marked and real, and has led to the same pressing problems of administration, the same deficiencies in the number of instructors, the floor space required, and the equipment of drawing rooms and laboratories. In the institutions east of the Mississippi, the problems have been met and solved through legislative action, generously appropriating the necessary funds. The Western colleges, on the other hand, have felt the influence of the trend toward this form of scientific training, without the stimulus of generous legislative aid, for the lack of which they are now at this present time suffering. This is especially true in Kansas, where the state institutions have no distinctive engineering buildings and an inadequate equipment for the number of technical students already on the ground, to say nothing of the increased numbers that are sure to come in the immediate future.

The distribution of students between the various technical lines is interesting and is shown by the following table:

NUMBER OF STUDENTS IN VARIOUS TECHNICAL COURSES IN AMERICAN COLLEGES.

COURSE.	Year 1899–'00.†	1901–'02.*	1902–'03.†	1903–'04.†	Per cent. of increase in four years.
Civil engineering	3,140	3,694	5,278	6,118	90
Mechanical engineering	4,459	4,163	6,800	6,894	55
Electrical engineering	2,555	2,648	3,652	4,389	72
Mining engineering	1,261	1,453	2,244	2,324	84
Chemical engineering	.....	353	725	694	.....
Sanitary engineering	.....	.....	27	31	.....
Textile engineering	.....	.....	133	95	.....
Naval architecture	.....	81	.....	.....	.....
Architecture	459	362	558	542	18
Special engineering	.....	2,159	.....	.....	.....
Total	11,874	14,913	19,417	21,087	.....

* From proceedings of Society for the Promotion of Engineering Education.
† From reports of United States Commission of Education.

The above figures will show the recent trend as between the various lines of study chosen by students, but one can hardly say that this represents a permanent distribution, for the time covered is too short to warrant such a judgment. However, the introduction of courses in textile engineering in several Southern institutions is worthy of note as a new departure, as is also the increasing num-

ber of those choosing to enter the field of chemistry as applied to manufactures. This is a field that is promising as well as relatively new, and one that is not by any means fully occupied at the present. The increase shown by civil engineering seems somewhat abnormally large, although one looks naturally for that course to to show more growth in the last few years because of the widespread activity in public enterprises using the services of a civil engineer, and because the civil engineer graduate, from the less highly specialized nature of his college training, finds more possible openings before him and those of a greater variety and range than the graduate of other courses. In this the mining graduate is closely allied to the civil, though the recent increase in the numbers of those choosing mining is undoubtedly due to the revival in mining operations. The relatively low increase in the number of mechanical students is probably due to the popularity of electrical engineering, which, because of this popularity, due to its almost wizard-like accomplishments, has perhaps drawn unduly from its closely related course, that of mechanical engineering. Electrical engineering in reality is a branch of mechanical engineering, and it is a question not yet settled how far the two courses should be differentiated.

It is probably true that some of our courses in applied electricity in our colleges are too highly specialized along electrical lines and include too little of subjects found in mechanical courses to obtain the best training for all-round engineering work.

The falling out of students as they progress from year to year is also an interesting point. In the year 1901–'02, of the 14,913 students of technical courses in American colleges, only 1485 are classed as seniors. This is 9.9 per cent. For the college year 1905–'06, the Massachusetts Institute of Technology catalogued 16.5 per cent. of its total number of engineering and architectural students as seniors; for the last year, Cornell University, 15.8 per cent.; Ohio State University, 9.3 per cent.; Purdue University 17.3 per cent.; University of Michigan, 10.2 per cent.; University of Wisconsin, 14.7 per cent.; University of Illinois, 13.4 per cent.; Iowa State College, 15.1 per cent.; University of Kansas, 9 per cent. There are various reasons for this. The courses cover more ground and are made up largely of stiffer and harder work than is found in the ordinary college course, especially if the latter is one allowing of a wide range of electives; the engineering courses are more exacting then on a student's time and effort and many get weeded out early. Many students start with engineering under a notion that it is a good thing for them because it leads to good

salaries, only to find that they are not adapted to that kind of work. Then the knowledge and training received in the years below senior, in times of great prosperity like this, become of money value, and many students from choice or necessity become wage-earners, or even engineers with limitations. This point operates strongly in Kansas. Another thing that influences the above percentages is the very recent rapid growth in numbers, which, of course, swells the ranks of the freshmen chiefly. Yet it is interesting to note that of the entire number of 118,000 students of collegiate grade in 1903–'04, only about 15,500 were given degrees at the end of the year. This is very close to 13 per cent., a figure which therefore can fairly be taken as an average for the whole country. There will come a time when more normal conditions will govern and the ratio of seniors to total number somewhat larger than above given. A strong influence in this direction is the growing tendency on the part of railways and manufacturing concerns to require graduation from a good technical school of those seeking engineering employment.

In the true professional schools (for the engineering school is not a professional school in any strict sense), the percentage of graduates to total enrolment is considerably higher, being 23 per cent. for law, 21 per cent. for medicine, 30 per cent. for dentistry, and 29 per cent. for pharmacy. The reasons for this probably are that those entering these professional courses are either more mature or more definitely settled in their choice than those entering college or a technical school. Moreover, the standards of work maintained by some professional schools have not heretofore been as high as those of the colleges, although there seems to be a general advance in this respect.

There is another point of interest to be touched upon growing out of this statistical study. The United States census for 1900 gives the number of engineers and architects in active practice, as follows:

Civil engineers	20,153
Surveyors	6,034
Mechanical and electrical engineers	14,440
Mining engineers	2,904
Chemists, assayers, and metallurgists	8,887
Architects	10,604
Designers, draftsmen, and inventors	18,956
Total	81,978

But, as the surveyors are rarely men of college training, as many chemists and most architects are not technically trained, and as the

class last mentioned above includes relatively only a small number of technical graduates, it is probable that the number of actual engineers at that date was not more than 50,000. Assuming that this number has increased to 53,000 at the present time, there is to be set against this body of practitioners the great body of 25,000 students, and we wonder what they are going to do, and ask whether this present trend of young men toward engineering is a healthful movement. We must look further to find an answer to the question.

It is said that the mean average growth of the number of wage-earners in America is about 3 per cent. per year, while the death rate is about 2 per cent. To provide for this growth and loss there would then be 5 per cent. of 53,000, or 2650 new engineers this year. If we assume 13 per cent. as the ratio of graduates to the total enrolment, as found above, this would furnish a body of 3250 with which to fill up the ranks. Hence, we might argue that the supply has reached or even overtopped the demand. Yet there is present another trend in modern affairs that sets this argument one side, and that is the growing recognition of the value of technical college training, followed by more or less of professional practice, as a basis for administrative business life. Engineers are constantly leaving the ranks of the profession for business openings, while young engineering graduates are accepting positions for which they are well fitted and in which they earn credit, but which can hardly be classed as strictly professional, although closely related thereto.

The truth is that any sound course in engineering is first of all educational, and professional only as a secondary matter. No school can make an engineer, for engineering as practiced is based on judgment, and this comes only as the result of experience. Some educators have tried to train young men into engineers, and some schools turn out graduates who believe that they possess technical wisdom, a notion that must needs be knocked out of them by hard experience before they can possess a sufficient amount of sense. The most that a school can do is to give a sound training, chiefly in mathematics and physical science and their applications, and an inculcation of principles, together with a small amount of professional knowledge, principally to help the young man to get a start without an exhibition of too much rawness. With it all, it must be recognized that the pupil is to be a man first and an engineer as a secondary matter. Indeed, he cannot succeed as an engineer without being true, honest, conscientious, simple-minded, open and frank, and without habits of hard work, of close and care-

ful observation, of weighing both sides of any point at issue, of searching for and clearly and strongly proclaiming the truth. Technical schools, in their laudable endeavor to fit men for practice, often for particular places, have sometimes lost sight of the real object of any right college work, and one of the encouraging things is another trend in engineering education that seeks to make more of the training of men as men without any real detraction from the scientific training.

That engineering courses are not professional is evidenced by the comparative ease with which young men, trained in one line in college, get into and succeed with another in practice. Civil engineers become miners, and *vice versa;* a miner becomes an expert in the cement industry; an electrical turns himself into a bridge engineer for a great railway. These and many other similar transformations have come within the writer's personal knowledge, as well as many instances of successful service in business or industrial life.

The young graduate, with his best acquisition a capacity for hard work, is somewhat the victim of circumstances and environment, and yet in the long run he will follow his bent and his natural likes. One becomes a scientific engineer, who loves his profession and his search for the truth in its problems, and who is content with a modest gathering of wealth. Another becomes a business engineer, attracted by the struggle of competition and the chances for accumulation. Both make use of their knowledge and scientific skill, but with slightly different aims. One seeks to obtain the best result for the least money expenditure; the other, so to plan that money returns may be the largest.

Our technical schools have largely planned their courses for the benefit of the first man, and it is a question that is now receiving consideration, whether they should not provide some specific training for the latter; and this is pertinent, because all engineers, of whatever type, necessarily must have to do with business affairs. It is certain that our engineering courses are strong in mathematics, the physical sciences, and their application and in drawing and design, at the expense of sufficient training in the use of English, a knowledge of the principles of economics, the elements of law, some study of business methods, the analyzing of the cost of production in manufacturing, some consideration of the principles of dealing with human nature and the handling of men, as well as some treatment of the matters of ethics and taste which materially affect a young man's outlook and his attitude toward life.

It is a serious matter to determine what to include and what to leave out in any four-year course of study, and in the present day this amount of time seems to be the maximum that one can expect to hold the great majority of students. Some things must be left out, and some left to be touched incidentally only through the personal influence of the teacher and his contact with the pupil. In the main, the engineering schools are quite close together as to their requirements, though courses of study are under constant discussion and are open to revision. In this matter there is no more potent agency at earnest work than the Society for the Promotion of Engineering Education, whose influence has been strongly felt in the thirteen years of its life.

There is yet another movement among the engineering colleges of very great import, not only indirectly to students, but directly to the public at large. This is a growing spirit of investigation, the attempt to take up and solve many scientific questions relating to the materials of construction, their use, or to methods of design. Twenty years ago there was very little of this kind of work done, outside of one or two institutions, and teaching was almost wholly led by practice; but to-day, the results of the thinking and investigation of the college men are leading the practitioners. The modern use of the alternating current grew out of the work of college men. The standardizing of the requirements for paving brick came from work done in a college laboratory. The Cornell hydraulic laboratory, with its unequaled opportunities, is open for the study of unsolved problems. The University of Illinois has published results of investigations concerning reenforced concrete, high-speed tool steels, the collapsing of tubes, the holding power of railway spikes, and the drainage of earth roads. The University of Wisconsin has made a valuable contribution to our knowledge of reenforced concrete. The Massachusetts Institute of Technology conducts postgraduate research work in sanitary engineering of great value. The Iowa State College is applying energy to investigations of economic value to the state. Indeed, there is hardly an institution of any great importance that is not doing some practical research work.

While the University of Kansas has done something along this line—investigations of building stone, paving brick, gas, oil, etc., and has in progress some study of stone for the improvement of roads, a systematic water survey of the state, in connection with the State Board of Health and the United States government, and other studies of public importance—the applied-science men of its

faculty have been too much occupied with the teaching function and too poorly supplied with space, equipment and money to warrant much development in this way. It is to be hoped that in the immediate future the state colleges of Kansas may be properly equipped to do systematic research work on economic engineering lines.

This movement is an exceedingly healthful one, for it adds strength and vitality to the teaching side of college life on the one hand, and furnishes scientific results of a high order on the other. College men are better adapted to study, investigate and draw unprejudiced conclusions concerning questions of this kind than any other class. They can have—indeed, are likely to have—a better equipment in the way of literature, laboratories, apparatus and other facilities as a basis for work; they are in close touch with workers in all scientific lines; only they must have both time for the work and available funds.

In conclusion, the writer believes that the trend of American youth toward colleges of applied science is a healthful movement, fully justified by the conditions of life as they now exist and will exist for many years to come; that applied-science college work furnishes a pretty severe training, leading to habits of industry, honesty in forming opinions, respect for truth, and a knowledge of how to attack and master real problems; that this training results in a class of men who bring things to pass; that it possesses a definite cultural value, though limited in its scope.

He further believes that applied-science colleges are but beginning their career of usefulness, not only as places for the higher education of youth, but also as centers of applied science, where investigations of utilitarian questions go on side by side with those of pure science—not simply side by side, rather with hand in hand; for no new truth of science is discovered but that, sooner or later, it is found to have its practical application somehow or somewhere.

He still further believes that every college of engineering, to rightfully fulfil its mission to both pupil and public, should include both functions, that of teaching and that of doing research work.

And finally, he believes that the spirit underlying the work of these colleges is such that they will not be content with present attainments and present standards of efficiency. Recognizing defects and limitations, they must and will struggle and work for better and higher results.

It is a serious matter to determine what to include and what to leave out in any four-year course of study, and in the present day this amount of time seems to be the maximum that one can expect to hold the great majority of students. Some things must be left out, and some left to be touched incidentally only through the personal influence of the teacher and his contact with the pupil. In the main, the engineering schools are quite close together as to their requirements, though courses of study are under constant discussion and are open to revision. In this matter there is no more potent agency at earnest work than the Society for the Promotion of Engineering Education, whose influence has been strongly felt in the thirteen years of its life.

There is yet another movement among the engineering colleges of very great import, not only indirectly to students, but directly to the public at large. This is a growing spirit of investigation, the attempt to take up and solve many scientific questions relating to the materials of construction, their use, or to methods of design. Twenty years ago there was very little of this kind of work done, outside of one or two institutions, and teaching was almost wholly led by practice; but to-day, the results of the thinking and investigation of the college men are leading the practitioners. The modern use of the alternating current grew out of the work of college men. The standardizing of the requirements for paving brick came from work done in a college laboratory. The Cornell hydraulic laboratory, with its unequaled opportunities, is open for the study of unsolved problems. The University of Illinois has published results of investigations concerning reenforced concrete, high-speed tool steels, the collapsing of tubes, the holding power of railway spikes, and the drainage of earth roads. The University of Wisconsin has made a valuable contribution to our knowledge of reenforced concrete. The Massachusetts Institute of Technology conducts postgraduate research work in sanitary engineering of great value. The Iowa State College is applying energy to investigations of economic value to the state. Indeed, there is hardly an institution of any great importance that is not doing some practical research work.

While the University of Kansas has done something along this line—investigations of building stone, paving brick, gas, oil, etc., and has in progress some study of stone for the improvement of roads, a systematic water survey of the state, in connection with the State Board of Health and the United States government, and other studies of public importance—the applied-science men of its

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II.

CHEMICAL AND PHYSICAL PAPERS.

"Coffee and Estimation of its Value."
By L. E. Sayre, University of Kansas, Lawrence.

"The Relation of the New Food and Drug Law to the Official Preparations."
By L. D. Havenhill, University of Kansas, Lawrence.

"Drug Standards with Reference to the Pure Food and Drug Law."
By L. E. Sayre, University of Kansas, Lawrence.

"A Most Wonderful Tool."
By John H. Klopfer, Topeka.

"The Modulus of Lunar Influence—not in a Lifting, but in a Falling Movement."
By John J. Jewett, Sawtelle, Cal.

"The Spectrum and Spectrum Scales."
By J. T. Lovewell, Topeka.

"The Quantitative Estimation of Iron and Cobalt by the Rotating Cathode."
By R. W. Curtis and S. A. McReynolds.

"Notes on Kansas Road Metal."
By F. O. Marvin, University of Kansas.

"The Development of Forest Belts in the Northwestern Part of Clay County, Kansas."
By John H. Schaffner, Columbus, Ohio.

"Helium in Natural Gas."
By H. P. Cady and D. F. McFarland, Lawrence.

"A Note on the Detection of Cyanides."
By H. P. Cady, University of Kansas.

"Note on Mercurous Sulfate for Standard Cells."
By H. P. Cady, University of Kansas, Lawrence.

"A Proposed Test for Bleached Flour."
By J. T. Willard, Agricultural College, Manhattan.

"On Some Ferrocyanides of Calcium, Barium, and Magnesium."
By F. B. Dains, Topeka.

"Determination and Comparison of Sound Intensities."
By Bruce V. Hill, Lawrence.

COFFEE AND ESTIMATION OF ITS VALUE.

By L. E. Sayre, University of Kansas, Lawrence.

IN volume II, page 50 (1887–'88), of the Proceedings of the Kansas Academy of Science, there is published an article by the author on the alkaloidal strength of teas. In answer to the question, Is the alkaloidal strength of tea an index of its commercial value? it was shown that a negative answer to this question must be given; that the alkaloidal strength has no relation to the commercial price. For example, it was shown that a tea rated at 25 cents per pound contained 2.49 per cent. of theine, while a tea at 90 cents per pound contained 3.73 per cent. of theine, and that a tea at 60 cents per pound contained 3.67 per cent. of theine, showing that commercial price was no index to alkaloidal strength. Applying the same question to coffee, we have found the same to be true. A fine Mocha will contain about 0.64 per cent., while another of a different variety, and about the same price, will contain 1.53 per cent of caffeine.

In determinations of caffeine from coffee recently made in our laboratory, it has been found that the percentage of caffeine in coffee varies considerably according to the locality where it has been cultivated. Some coffees have ranked as high as 1.97 per cent. of alkaloid, while it is very commonly the case that an excellent coffee, commanding a good price, will yield as low as 0.8 per cent. of the alkaloid. The importance of this fact has never been applied as it might be, as there are some to whom the stimulating effect of caffeine is undesirable, while there is at the same time a demand for a beverage that shall have an agreeable taste. On the other hand, there are others to whom the stimulating effect of caffeine may be an advantage. The quality of roasted coffee is dependent mainly upon the substances which occasion the peculiar aroma. These substances have thus far been practically unknown. Erdmann, in *Berichte der Deutschen Chemischen Gesellschaft*, 1903, refers to the oil of coffee which has been obtained by treating roasted coffee with steam. The yield from 150 kilograms of roasted and ground Santos coffee was 83.5 gm., or 0.055 per cent., of an oil of a brown color, of a specific gravity of 1.0844, and a strong odor of coffee. On distillation of the oil, the greater portion passed over between 150 and 190° C. in the form of a light-colored oil. This contained furfur

alcohol, and much valerianic acid. The constituent having the characteristic aroma of coffee is said to be nitrogenous and not a phenol, as has been assumed heretofore. The exact isolation has not been possible so far. It is well known that the roasting of coffee carries with it antiseptic and deodorant properties. This is evidently inherent in the volatile products of roasted coffee, and possibly due to phenols present in these volatile products.

Our own experiments in the investigation of the volatile aromatic constituents of roasted coffee have led us to the conclusion that these when isolated are extremely volatile. For example, when chloroformic and petroleum ether solutions of the coffee are evaporated at extremely low temperatures it is found that the aroma evaporates and diffuses through the air at a lower temperature than that at which the ethereal liquids evaporate. We have endeavored, therefore, to resort to another method of recovering the volatile aromatic oil, which consisted in placing in a retort 500 gm. of finely powdered coffee and connecting the retort with a condenser and two receivers in tandem, the first receiver being refrigerated with ice and salt and the second refrigerated with liquid air. Only a few drops of a colorless liquid was recovered from the dry distillation in the second receiver. It is nearly colorless and has an odor suggesting that of capronic acid. It is very powerful and penetrating, diffuses very rapidly in the air, and when highly diluted with atmospheric air suggests the odor of coffee. The distillate obtained in the first receiver, of a yellowish-brown color, has an ammoniacal odor. But it is evident that the characteristic aroma of roasted coffee is due to a mixture of different compounds not obtained by any such process. We have not been able to pursue further this investigation, but hope at some future time to recover a sufficient amount of the distillate mentioned to purify the same and to make an analysis of it. The claim that oil of coffee may be obtained by distilling coffee with steam under pressure and collecting the distillate by means of ether and then evaporating the ethereal solution does not seem to us to be well founded, as we have not been able to obtain a volatile oil by this process which has the suggestion of the aroma of coffee. As we have said, ethereal and chloroformic solutions of the volatile products usually leave behind on evaporation little or no residue that are characteristic of the aromatics in coffee, these aromatics becoming evaporated on evaporation of the solvent, even though the solvent is evaporated at a very low temperature.

ANALYSIS.

In the analysis of coffee we have as yet no standard that would estimate the value of coffee from the commercial standpoint. The bureau of chemistry of the United States Department of Agriculture, in its standard for this beverage, makes the following statements:

1. Coffee is the seed of *Coffea arabica* L. or *Coffea liberica* Bull., freed from all but a small portion of its spermoderm, and conforms in variety and place of production to the name it bears.

2. Roasted coffee is coffee which by the action of heat has become brown and developed its characteristic aroma; it contains not less than ten per cent. of fat and not less than three per cent. of ash.

In Bulletin No. 90 of the bureau of chemistry of the Department of Agriculture, page 43, there are two processes mentioned for the determination of caffeine and caffeotannic acid, which I hereby transcribe:

Caffeine.

Method of Hilger and Fricke (*a*).—Take 5 to 10 grams of coffee, add 100 cc. of water, and boil, filter, and treat the residue twice more with boiling water. Add to the united filtrates an excess of lead acetate, filter, and wash. Treat the filtrate with hydrogen sulfid to remove the excess of lead, filter, wash, and evaporate the filtrate to dryness in a Hoffmeister schälschen with some sand and a little magnesia. Crush the schälschen between filter-paper, place in a continuous-extraction apparatus, and extract with chloroform until exhausted. Dry the chloroform extract at 100 degrees and weigh as caffeine. If the caffeine does not appear to be pure, determine the nitrogen in the residue by the Gunning method. $N \times 3.464 =$ caffeine.

Caffeotanic Acid.

Krug's method (*b*).—Treat two grams of the coffee with 10 cc. of water and digest for thirty-six hours, add 25 cc. of 90 per cent. alcohol and digest twenty-four hours more, filter, and wash with 90 per cent. alcohol. The filtrate contains tannin, caffeine, color, and fat. Heat the filtrate to the boiling-point and add a saturated solution of lead acetate. If this is carefully done a caffetannate of lead will be precipitated, containing 49 per cent. of lead. As soon as the precipitate has become flocculent, collect on a tared filter, wash with 90 per cent. alcohol until free from lead, wash with ether, dry, and weigh. The precipitate has the following composition: $Pb_3C_{15}H_{18}O_{82}$. The weight of the precipitate multiplied by 0.51597 gives the weight of the caffeotannic acid.

Dr. Wilhelm Autenrieth, in his work on the detection and estimation of alkaloidal substances, page 185, gives a résumé of the literature on the estimation of caffeine of caffeine-bearing plants, and gives six different methods. We have tried these various methods, and have found the Katz method to be the most satisfactory. This method is as follows:

Shake 10 grams of powdered coffee or tea for thirty minutes with 200 grams of chloroform and 5 grams of ammonium hydroxid solution. When the liquid has settled filter 150 grams of the chloroform solution, which should be perfectly clear and free from water. Distil the chloroform and dissolve the residue with gentle heat in about 6 cc. of ether. Add 20 cc. of 0.5 per cent. of hydrochloric acid and, in an assay of coffee, also 0.2 to 0.5 grams of solid paraffin. Evaporate the ether and filter the cold, aqueous solution. Wash the flask and filter-paper a few times with small portions of 0.5 per cent. hydrochloric acid. Finally extract the total aqueous hydrochloric acid solution four times with 20 cc. portions of chloroform. Distil the filtered chloroform extracts, dry the residue, and weigh. This residue will consist of nearly pure caffeine.

The one difficulty in all of these processes is that the caffeine recovered in the process contains some coloring matter or some empyreumatic matter imparting color to the product. It has been suggested that when the yield is thus contaminated the crystals be subjected to the Kjeldahl's nitrogen determination. The quantity of anhydrous caffeine is calculated on the basis of this analysis. One cc. of $\frac{N}{10}$ oxalic acid represents 0.00485 grams of anhydrous caffeine. Tetrachlormethane has been suggested by some analysts as a proper substitute for chloroform in the extraction of the alkaloid. We have found that an almost colorless caffeine can be obtained by properly using this solvent. It has been our endeavor to obtain a simple process by which we could estimate the caffeotannic acid and the caffeine at the same time. We have thus far had quite accceptable results by using a modification of the Krug method. Instead of using 2 gm. of the coffee, 7 gm. of the finely powdered coffee are taken. After digestion with the water and alcohol (as required by the formula) for twenty-four hours, 100 cc. of the filtrate, which is made to represent 5 gm. of the coffee, are taken. This is precipitated by the solution of lead acetate, and 60 cc. of the filtrate, representing 3 gm. of the coffee, are taken and treated with an excess of diluted sulfuric acid. The filtrate from the lead sulfate, which has been thoroughly washed, is carefully evaporated to remove traces of alcohol, and the residue is filtered into a separatory funnel and thoroughly washed with 15,

10, 10 and 5 cc. of chloroform, added in succession to the aqueous solution. The mixed chloroformic solutions are then evaporated to dryness and the resulting crystals of caffeine, if they contain an appreciable amount of coloring matter, are redissolved in a mixture of petroleum, ether, and chloroform, which gets rid of small quantities of color. This latter solution when filtered is evaporated and the crystals are weighed, and from the weight the percentage of alkaloid computed. The results that we have thus far obtained show concordant results. Samples of roasted coffee as obtained upon the market have given from 0.825 to 1.66 per cent. of caffeine, and of caffeotannic acid (or plant acids estimated as caffeotannic acid) from 10 to 12.8 per cent.

We desire to append to the present article the analysis of samples of coffee of different varieties which we have collated from the Proceedings of the American Pharmaceutical Association, volume 24, page 144, and, for the benefit of those who are interested in assay, we would call attention to the tables which accompany the most excellent article on the chemical constituents of coffee presented in Bulletin No. 90 of the Department of Agriculture, pages 43 to 45, inclusive.

ANALYSES OF SAMPLES OF COFFEE.

VARIETIES.	Caffeia.....	Fat.....	Mucilage....	Caffeotannic acid....	Cellulose....	Ash.....	Potassa.....	Phosphorus.
Finest plantation Jamaica.....	1.43	14.76	25.3	22.7	33.8	3.8	1.87	0.31
Finest green Mocha.....	0.64	21.79	22.6	23.1	29.9	4.1	2.13	0.42
Pearl plantation Ceylon	1.53	14.87	23.8	20.9	36.0	4.0	....	0.27
Washed Rio.....	1.14	15.95	27.4	20.9	32.5	3.5	....	0.51
Costa Rica.....	1.18	21.12	20.6	21.1	33.0	4.9	....	0.46
Malabar.....	0.88	18 80	25.8	20.7	31.9	4.3	....	0.60
East India.....	1.01	17.00	24.4	19.5	36.4	....	....	....

Proc. Am. Pharm. Ass'n, vol. 24, p. 144.

Paul and Cownley proved that a small amount of caffeine is lost in the roasting of coffee. To illustrate this, three samples are given: First, one roasted to extreme degree; second, one just far enough to give berries a fine chestnut-brown color; third, coffee roasted to pale brown color, when aroma was not fully developed.

COFFEE.	Loss of weight in roasting.	In raw coffee.	In roasted coffee.	
			Found.	E timated.
Low roasted.....	13.7%	1.10%	1.30%	1.28%
Medium roasted.....	16.0	1.10	1.36	1.31
High roasted.....	31.7	1.10	1.25	1.61

Proc. Am. Pharm. Ass'n, vol. 35, p. 142.

Julian E. Walker gives his results of the analysis of several kinds of roasted coffee for percentage of caffeine in different sorts:

Java	0.89%
Siberian Java	1.08
Salvador	1.01
Costa Rica	1.24
Mocha	0.54
Peaberry or Fenroll	0.77
Rio	1.12

Proc. Am. Pharm. Ass'n, vol. 38, p. 446.

ANALYTICAL RESULTS EMPLOYING VARIOUS SORTS.

W. T. A. Warner examined a large number of coffees in the laboratory of the colonial museum at Haarlem, conducting his researches with particular reference to the Siberian coffee cultivated in Java as a substitute for Arabian coffee:

SAMPLES OF SIBERIAN COFFEE.	H_2O Ext.	C_2H_5OH ext., per cent.	Fat, per cent.	Caffeine, per cent.	Ash, per cent.	Phosphoric acid in ash, per cent.	Potash in ash, per cent.
Sindjas	32.92	17.43	12 26	1.29	3.87	8.95	72.05
Timor	32.05	16.60	13.23	1.11	3 96	7.87	78.78
Banthain	30.38	18.89	14.78	1 11	4.29	10.26	77.83
Boengi	31.09	18.41	16.10	1.03	3.88	12.37	71.47
Loewae	30.13	17.82	16.06	1.48	4.30	11.25	79.90
Waloe Pengenten	26.98	17 85	13.57	1 25	3.97	9.47	76.91
Kaui Redjo	29.59	18.89	15 43	1.00	3.74	10.67	? rep.
Taman, Tjiasem	30.47	19.91	16.48	1.39	4.09	10.27	67.57
Malang	30.21	19.81	16.36	1.07	4.11	11.08	63.82
Averages	30.00	.....	15.00	1.00	4.00	.....	.....

The water extract was obtained by boiling five minutes with distilled water; the alcohol extract, by boiling during half an hour with ninety-five per cent. alcohol; the fat, by extraction with ether; the alkaloid, by one of three methods, viz., van Romburgh's, van Ledden-Hulseboch's, and George's, preference being given to van Romburgh's method, which consists in shaking out the aqueous extraction, after addition of lead acetate with chloroform.

The following table gives a comparison of raw and roasted Java-Arabia and Java-Siberia coffees. The extracts, unless otherwise indicted, are obtained by the action of each solvent on fresh portions of the same coffee. The coffees represent good qualities of the market during 1898.

	Raw Malang, per cent.	Roasted Malang, per cent.	Raw Liberia, per cent.	Roasted Liberia, per cent.
Aqueous extract	33.52	27.40	35.16	34.17
Alcoholic extract	19.38	16.12	18.62	17.27
Ether-alcoholic extract	17.70	16.53	15.80	15.92
Chloroform extract	15.65	17.91	13.88	15.10
Ether extract	13.63	14.20	12.19	13.13
Petroleum ether extract	12.51	14.31	10.84	11.68
Ether extract after petroleum ether	1.08	4.74	0.75	3.14
Chloroform extract after petroleum ether	1.08	1.41	1.18	2.60
Alcohol extract after petroleum ether	3.14	5.37	8.68	2.79
Nitrogen	2.83	2.77	2.73	2.89
Caffeine	1.16	1.57	1.59	2.19
Albuminoids	15.74	14.71	14.43	14.42
Cellulose	28.75	20.47	26.68	15.32
Pentoses	5.14	3.15	5.01	2.44
Ash	4.46	4.83	4.02	4.37
Water	11.24	5.64	11.40	3.98

Proc. Am. Pharm. Ass'n, vol. 48, p. 608.

CHASE & SANBORN COFFEE.

Ash, sample No. 1.. 3.98 per cent.
" " No. 2.. 3.92 "
" " No. 3.. 3.96 "
Total..... 11.86 per cent.
Average..... 3.95 per cent.

Samples:
A..... 0.196 per cent.
B..... 0.194 "
C..... 0.192 "
Av. moisture, 0.194 in 10 grams.
Present moisture, 1.94 per cent.

Ash:
3.89 per cent.
4.096 "
4.046 "
3.142 "
Av., 3.996 per cent.

Fat (Chase & Sanborn):

	Fat.	
50 gr.	8.0505 = 16.101	per cent.
50 gr.	8.0980 = 16.196	"
50 gr.	8.0275 = 16.055	"
50 gr.	7.8708 = 15.7416	"
50 gr.	7.9270 = 15.8540	"

RELATION OF THE NEW FOOD AND DRUG LAW TO OFFICIAL PREPARATIONS.

By L. D. Havenhill, University of Kansas, Lawrence.

At the present time, when so much is being said and written concerning wholesale adulteration and substitution, it is no wonder that people are becoming suspicious of almost if not quite everything with which they come in contact. That they feel their inability, as individuals, to cope with these alarming conditions is evidenced by their demand for legislative enactments for their protection.

This condition of affairs is especially true with reference to foods and drugs, substances so specifically essential to the health of the human family. These two classes of substances are usually grouped under a common head, especially in our statutes, though in reality they have little in common aside from their relation to the health of the individuals of the nation.

The United States government has for a number of years been actively engaged in the analysis of foods and the publication of methods for their analysis, and for the detection of their chief adulterants. It is, however, only recently that it has interested itself in the question of drugs and their adulterants, but it is interesting to note in this connection that it considered this branch of investigation sufficiently removed from the province of food chemistry to equip a new laboratory for this purpose, and to place it under the immediate direction of a man who is not only a trained pharmacist and chemist but one who has for years been actively engaged in the preparation and analysis of drugs and medicines. Several bulletins have already been issued by the chief of this new laboratory and many important problems are now in the course of solution. Aside from the activity displayed by the federal government in the interests of pure foods and drugs, several states are beginning to evince an activity in this direction, Kansas among others. This state has had for years a good law regulating the quality of foods and drugs, but it had almost become a dead letter through want of an enforcing officer. The last legislature, however, took action in this direction with reference to foods, and since January of this year a considerable amount of investigation has been done by the State Board of Health. This organization has also interested itself in the question of pure drugs, and there is

every indication that the next legislature will enact laws which will place Kansas in the front rank with those states that control the character of their foods and drugs.

The cause for adulteration in drugs is much the same as for adulteration in foods, and the remedies will be along the same lines. So long as our grandmothers gathered the yearly stock of medicinal herbs and dried them in the garret there was no more question concerning their efficacy than there was as to the wholesomeness of the food prepared by the same individual, but when the drug collecting, as also a very large part of the food preparation, passed from unselfish, loving hands into those motived very largely by a desire for pecuniary gain, people in general began to inquire more closely into their origin. In opposition to this class of individuals, whose aim primarily is perhaps not so much to defraud as to secure for themselves more of the worldly goods, came those who demanded the "square deal," and who began to devise simple tests whereby the quality of the crude article could be at least roughly ascertained. The discovery of alkaloids and other chemical principles in drugs, to which their therapeutic efficiency is very largely attributed, gave at once a chemical method for their valuation. The first vegetable drug to be valued by this standard was opium, the drug in which the first alkaloid was discovered.

The real beginning of the movement to secure uniformity in medicines antedates the first pharmacopœia, that of 1820, but the first pharmacopœia to contain chemical tests of any importance for the valuation of drugs was the United States Pharmacopœia of 1880. Here we find standardized by volumetric assay thirty-seven inorganic chemicals, six organic chemicals, and fifteen preparations for an inorganic constituent, besides a few gravimetric assays, including the assay of two drugs — opium and cinchona — for alkaloidal constitutents. In the next revision of this pharmacopœia the list of standards was much extended, and in the latest revision of this book, the eighth, commonly called the "United States Pharmacopœia of 1900," this list was still further extended. Comparing the number of quantitative tests in this book with those in the previous pharmacopœia, we find that where we formerly had only 114 volumetric and 14 gravimetric assays, we now have 149 volumetric and 35 gravimetric assays.

The articles standardized in the pharmacopœia of 1900 conveniently come under three heads: First, the chemical substances; second, the crude products derived from the vegetable and animal kingdom; and third, the preparations or the medicines compounded

from the first two classes. The chemical substances in the first class number about 300, and practically all of them are required to conform to certain prescribed chemical and physical requirements. The substances included in the second class, numbering about 240, are practically all accurately described, and about 50 of them have, in addition, a chemical method of valuation. In the third division, the preparations, there are 34 classes, which comprise 413 formulas. In 21 of these classes there is no attempt at standardization or description of any kind. In the remaining 13 classes there are 40 preparations for which there are volumetric assays, 17 preparations for which there are gravimetric assays, 1 preparation gasometrically assayed, and 18 preparations for which there are qualitative tests for purity only. This leaves 337 preparations in the pharmacopœia, or more than 80 per cent. of them, without any official description, definition, or standard.

The federal pure food and drug law which goes into effect January 1, 1907, states that drugs, and these are defined in the broadest sense of the term, so as to include, "all medicines and preparations recognized in the United States Pharmacopœia or National Formulary for internal or external use, and any substance or mixture of substances intended to be used for the cure, mitigation or prevention of disease of either man or other animals"—it states that these drugs "shall be deemed adulterated if, sold under or by a name recognized in the United States Pharmacopœia or National Formulary, they differ from the standard of strength, purity or quality as determined by the test laid down in the United States Pharmacopœia or National Formulary official at the time of investigation." Provision is made whereby these drugs may not be considered adulterated, provided they are properly labeled with reference to their quality. The National Formulary referred to is purely a book of formulas, without any so-called tests, either chemical or physical. Its formulas, 570 in number, are thus added to those of the pharmacopœia, making a total of 983 preparations, of which 907, or more than 92 per cent., are unstandardized.

The analysis of the preparations is by far the most difficult of the three classes of pharmacopœial substances, and it is here that the analyst who is not a trained pharmacist as well as an expert chemist needs to display the greatest caution, for surely the man without experience in putting these different drugs together is a poor judge of how to take them apart in a way to show whether the official formulas have been properly compounded or not.

The mere fact that a tincture which is prepared by extracting a given drug with diluted alcohol is found to be of lower alcoholic

strength is not necessarily an indication that the tincture has not been properly made, or that it is not of official quality. It is comparatively easy to decide whether a crude drug corresponds to the official definition and description, but after this drug has been broken into particles previous to making it into a preparation its quality is much more difficult to ascertain, and to judge of its quality from the finished preparation is unfortunately far too often an impossibility.

The absence of the physical characteristics from a preparation which are well known to the experienced druggist should go far towards condemning the preparation; but, on the other hand, their apparent presence is a poor guaranty for genuineness, for it is in this very particular that the skilful sophisticator takes pride in his iniquity and frequently outdoes himself. This is especially true in the case of colored and odorous preparations. Take, for example, the well-known tincture of vanilla; it is safe to say that but few people have any acquaintance with the pure article, and if they were allowed free choice between the pure and the factitious they would in the majority of instances choose the latter, though the relative value of it, based upon its actual cost, is not one-third that of the official article. It is in cases of this kind that the misbranding clause in the new law is especially pertinent. If you prefer the genuine, buy your tincture of vanilla, United States Pharmacopœia; if you prefer the factitious, buy the compound tincture of vanillin, National Formulary; if you belong to the don't-care class, continue to use the "extract of vanilla," which is generally inferior in quality to either of the others, and usually as high, if not higher, in price.

Besides the flavoring essences, the spices and condiments will also be affected by this clause, but in a way that will work to the good of the consumer. The result of adulteration in such articles, however, is of little moment when compared with the seriousness of adulteration in the realms of medicines proper. In this connection, it should be borne in mind that the further removed from the crude drug the medicine is, the greater the opportunity for adulteration and the less the chance for detection. In view of these points, and in spite of the new law, the fact still remains that the only safe way at the present time is to patronize those druggists whom you know as men as well as druggists and whose ability and integrity you know to be above question. If it is your desire to use cheap drugs, they can furnish them as cheaply as any one; but in any case do not begrudge them their just compensation for the knowledge and skill they place at your disposal in time of need.

DRUG STANDARDS WITH REFERENCE TO THE PURE FOOD AND DRUG LAW.

By L. E. Sayre, University of Kansas, Lawrence.

THE enactment of the pure food and drug law has brought to the front, as was expected, many important facts regarding the question of standards. In the first place, the United States Pharmacopœia has become of the greatest importance, inasmuch as the law requires that the standards for drugs and medicines shall be based upon that authority. The United States Pharmacopœia will have, therefore, far greater authority than heretofore. The National Formulary is also mentioned as a standard; but this standard work, which is far inferior to that of the pharmacopœia, is of much more recent creation.

The framers of the law, it would seem, were not familiar with two important facts concerning these two national standards. The law seems to indicate that the pharmacopœia has a test for all of the remedial agents mentioned; and the law also indicates that the National Formulary has standards for preparations it recognizes. Now, the facts are the United States Pharmacopœia does not prescribe tests for over fifty per cent. of the preparations it authorizes; and the National Formulary prescribes practically no tests whatever for assaying its preparations; therefore, the question of standards becomes a very important one.

It is said the pharmacopœia has been found, since the enactment of the pure food and drug law, to have standards and processes of assaying which in some cases should be amended. The manufacturers of chemicals and remedial agents have been greatly excited over this question. They have pointed out some errors of a minor character, it is true, some of them being plainly errors of figures, melting- and boiling-points, etc., which should be revised. It is plain that the committee of revision will be obliged to take up the question of correcting any errors and defective tests, and a supplement to the pharmacopœia will have to be issued. The work before the committee of revision will take some time, but it is to be hoped that the standards will be as high as they have thus far been prescribed, while at the same time there will be no injustice to the manufacturing industry nor to the consumer in making the few revisions proposed. It has been stated that there are a few tests in the pharmacopœia which are needlessly rigid. Undoubt-

edly this question will be considered, and in due time reported upon.

It should be stated in this connection that methods of assay or examination should be agreed upon for preparations of the United States Pharmacopœia and National Formulary, for which there are no prescribed tests.

Take, for example, the fluid extract of taraxacum. It is well known that there is upon the market an article which is sold as the American dandelion, and this is known to have been sold for taraxacum. The question occurs, How shall we assay the fluid extract of taraxacum to ascertain whether it has been adulterated with fluid extract of chicory? There is a method known to the pharmacist, but this is not mentioned in the pharmacopœia, nor have any tests been agreed upon for the purpose of standardizing such a preparation. Take another example, where we have the fluid extract of columbo. This has been adulterated with what has been known as American columbo, but there has been no prescribed method of assay or examination recognized in the pharmacopœia. The expert pharmacist is able to detect the presence of American columbo, but, as I have stated, no recognized method of examination has been adopted. It seems to us that cases of this kind will have to be seriously considered if we are to make the National Formulary and the United States Pharmacopœia effective as is intended by the pure food and drug law.

It is unfortunate that there should exist any ambiguities or misunderstandings as to standards, but this seems at the present stage inevitable. Still, it is quite possible for the pharmacist to take care of the medicinal preparations for which there is no test provided, by employing tests known to himself. This will have to be done until a uniform process of examinations of such medicinal preparations is agreed upon.

Some of our large manufacturers are very much exercised as regards the retroactive character of the law, which seems to be one of its features.

It is to be hoped that the manufacturers will find that they have overestimated the difficulties in view of the retroactiveness of the law. Under the guidance of such a man as Doctor Wiley, we feel, while the law will be rigidly enforced, the spirit rather than the letter will be made the principal feature; and if this is to be the policy, it seems to us that we shall not have any clamor on the part of manufacturers and wholesalers against it from this point of view. It is unquestionably true that manufacturers have shown not only

a willingness, but an earnest desire to comply with all the provisions laid down in the law itself, and are willing to cooperate in every possible way in making the same effective and practical in its operation.

In a current issue of one of the pharmaceutical journals, it refers to the law in these words: "Don't worry over the pure food and drug act of 1906, unless you sell goods in some state other than the one in which you live. Every article which you have in your stock January 1, 1907, may be sold to your home trade without restriction, and all articles which you receive after January 1, will be pure and will conform to the new law, and you will be held harmless under its operations, provided you purchase your supplies from a reputable house whose guaranty is registered at Washington." It further states that "we will guarantee that all articles of food or drugs manufactured, packed, distributed or sold by us, including both food and powdered drugs, chemicals, pharmaceutical preparations, medicinal specialties, proprietary medicines, etc., are not misbranded within the meaning of said act."

Few members of the community realize what an immense amount of work will be required for the manufacturer and wholesale dealer to comply with section 8 of the law relating to labeling by the time specified. The major part of the work on the part of the manufacturer and dealer lies in the direction of taking care of the stock which is already distributed among wholesale dealers and jobbers. Some are inclined to make the statement that if the law be rigidly enforced as to these already distributed goods it will be practically inoperative because of the difficulty of carrying out its provisions.

One firm has made the statement that it will require 100 extra men from this time on to go over the stock that is now distributed in the wholesale market, stored away in original packages, which will have to be opened and repacked, to say nothing of the goods that they are obliged to put out between now and January 1, if obliged to distribute them as they have been accustomed to do, for the reason that it will take them at least a month or more to readjust their different departments to comply with the law in connection with the goods that will be shipped after the 1st of January. We believe that, while there are a great many complications and numerous adjustments to be made, Doctor Wiley is going to take the position that the manufacturers of the country as a rule are honest and upright citizens. He said, in his interview with the manufacturers and proprietors of medicinal agents, that the execution of the law rested more in their hands than in the judicial de-

partments, and he hoped that the regulations would be so planned that there will never be cause for prosecution, and that the district attorney will never be called upon to press a suit.

Certainly if Doctor Wiley takes that position, as we believe he does, honestly and squarely, he will give, as the representative of the United States official, a fair and liberal treatment to those concerned in this great question.

It is evident that the principle which shall govern the department in Washington is that every article must bear a label which tells the truth, and if manufacturers put upon the market, knowingly and wilfully, substances which differ from the standards, that difference must be clearly stated upon the label. If that principle is carried out it will be a great boon to the profession of pharmacy and medicine. It will have the immediate effect certainly of making it easier for the pharmacist and physician to obtain good and reliable material, and the ultimate effect will be to raise the standard and dignity of the profession of pharmacy. We are therefore thankful for the law as it is, although it may have, as is frequently the case with new laws, certain imperfections and shortcomings.

A MOST WONDERFUL TOOL.

By John H. Klopfer, Topeka.

THE amazing adaptability of the steel square to the solving of a thousand and one problems in mathematics which puzzle the carpenter, will surprise those who know the square only as an instrument of measuring and squaring of boards and timber, and trying up angles.

In conjunction with the square it will be necessary to have a good four-fold, two-foot rule, with the duodecimo or twelfth scale marked on one of its outer edges. The outer edge of one side of the steel square, on both the tongue and blade, has each inch divided into twelfths. This is the side which will be mostly used, as each inch will represent one foot, and each subdivision one inch, or a scale of one inch to the foot.

The standard steel square has a blade 24 inches long and 2 inches wide, and a tongue 14 to 18 inches long, $1\frac{1}{2}$ inches wide. The blade is exactly at right angles with the tongue, and the angle formed by them is an exact right angle or square corner.

A proper square should have the ordinary division of inches, half-inches, quarters and eighths, and often sixteenths and thirty-seconds. Another portion of the square is divided into twelfths of an inch; this portion is simply a scale of twelve feet to an inch, and is used for any purpose, as measuring scale, drawing, etc. The diagonal scale on the tongue near the blade, often found on squares, is thus termed from its diagonal lines. However, the proper term is centesimal scale, for the reason that by it a unit may be divided into 100 equal parts, and, therefore, any number to the one-hundredth part of a unit may be expressed.

In this scale A–B is one inch; then, if it be required to take off $\frac{73}{100}$ inch, set one foot of the compass in the third parallel, under 1 at E, extend the other part to the seventh diagonal in that parallel at G, and the distance between E and G is that required. For E–F is one inch and F–G 73 parts of an inch. Upon one side of the blade of the square running parallel with the length will be found nine lines divided at intervals of one inch into sections or spaces by cross-lines. This is the plank, board and scantling measure. On each side of the cross-lines referred to are figures, sometimes on one side of the cross-line and often spread over the line, thus: 1/4-9/–. We will suppose we have a board twelve

feet long and six inches wide. Looking on the outer edge of the blade we find 12; between the fifth and sixth lines under 12 will be found 12 again. This is the length of the board. Now follow the space along towards the tongue till we come to the cross-line under 6 (on the edge of the blade), this being the width of the board; in the space will be found the figure 6 again, which is the answer in board measure, namely, six feet.

On some squares will be found on one side of the blade nine lines, and crossing these lines diagonally to the right are rows of figures, as seven 1's, seven 2's, seven 3's, etc. This is another style of board measure, and gives the feet in a board according to its length and width.

In the center of the tongue will generally be found two parallel lines, half an inch apart, with figures between them; this is termed the brace rule. Near the extreme end of the tongue will be found 24–24, and to the right of these 33–95. The 24–24 indicates the two sides of a right-angle triangle, while the length of the brace is indicated by 33–95. This will explain the use of any of the figures in the brace rule. On the opposite side of the tongue from the brace rule will generally be found the octagon scale, situated between the central parallel lines. This space is divided into intervals and numbered thus: 10, 20, 30, 40, 50, 60. Suppose it becomes necessary to describe an octagon ten inches square: draw a square ten inches each way and bisect the square with a horizontal and perpendicular center line. To find the length of the octagon line, place one point of the compasses on any of the main divisions of the scale and the other leg or point on the tenth subdivision. This length being measured off on each side of center lines, touching the line of the octagon, will give the points from which to draw the octagonal lines. The size of the octagon must equal the number of places taken off from the tongue by the compasses.

We shall now proceed to lay off the lengths, cuts and bevels for the timber in a hip roof 24 feet wide by 32 feet long, the hips to be at right angles and the roof to have a pitch of 45 degrees, leaving a ridge of 8 feet, the distance from the plate to the center of the roof being 12 feet, and the rise of the roof being the same, measure with the rule diagonally across from tongue to blade on the outside edge having the twelfth scale from 12 to 12. The distance on the rule will be 17 inches, or feet, the length of common rafter, and the figures 12 by 12 will mark the heel or seat cut, and also the plumb cut against the ridge board. It will be noticed that every foot gains five inches on the diagonal. Next

the length of the hip rafter is wanted. Measuring from 17 on blade to 12 on tongue (17 representing the length of common rafter, and 12 the inward distance of the hip from plate to ridge, the hip being the diagonal of these), the distance as shown on the rule will be 20 $\frac{10}{12}$, or 20 feet 10 inches. For the heel or seat cut take 12 x 17 on the square, and lay on the side of the timber and mark on the blade or 17-inch end, and on the tongue or 12-inch end for the plumb cuts. For the side cuts against the ridge board take 17 and $20\frac{10}{12}$ and lay across the upper edge of the stick and mark on the $20\frac{10}{12}$ edge. For the backing of the hip rafter dress a portion of its upper edge with a jack plane, and run a gage on its center; lay the square on with the length of the hip rafter or $20\frac{10}{12}$ on the blade and 12 (the rise of the rafter) on the tongue; mark from the gage line to edge of timber on the tongue or 12-inch end, and then from the same point on center gage square straight out to the same edge; the difference between the two points at the edge of timber will be the distance to gage down on each side of the timber for the backing. Or, a bevel can be set to the scribe made on the top as described, and worked to. The rafter should not be backed until all the necessary framing of it is done. The next thing in order will be the framing of the jack rafters to fit in their places against the hip rafter. We will suppose that the rafters are spaced every two feet on the plate, and as we have seen that every foot gains five inches on the diagonal we know that each jack will be two feet ten inches longer as they range out from the angle of the plate. Dress off the upper edge of one of the common rafters, and allowing first for one-half the thickness of the hip rafter, space off a jack rafter every two feet ten inches on said common rafter. This will give the pattern or length for cutting every set of jacks. The side cut or bevel for the jack will be marked from the longest point by the figures 17x12 on the square; the plumb cut will be the same as that of the common rafters. To miter a purlin over or against a hip rafter, take 17 on the blade and 12 on the tongue and lay on the upper edge of the purlin in the direction of your cut, but this time scribe a mark on the 12-inch edge of the square; then turn the timber on its side, lay on the figures, and mark precisely the same way with the same figures, and the miter will be perfect, as you can test by taking the piece sawed off and reversing it against the cut; it will form the correct pitch and angle. If the roof is of different pitch, then different figures will have to be used, but the principle is the same. Supposing the roof has a rise of nine inches to the foot: if you

measure across the square from 12 on the blade to 9 on the tongue you will find 15 on the rule. Take 12 on the tongue and 15 on the blade, make the cutting mark on the purlin on the 12-inch edge, lay the timber on its side, and take 9x15 on the square, lay on, and mark across on the 9-inch edge, and the miter will be marked complete. So it will be seen that the figures which govern the pitch of the common rafters must be kept in mind all through.

A little practice with the problems above set forth will make the beginner familiar with the methods and enable him to comprehend the principles. The above will work out any problem of cuts in the framing of an ordinary roof. For the more complicated problems, such as cuts for irregular hip roofs, bevels of hoppers, cutting spring moldings, etc., a deeper study into the principles of the square is necessary.

THE MODULUS OF LUNAR INFLUENCE, NOT IN A LIFTING, BUT IN A FALLING MOVEMENT.

By J. J. JEWETT, Sawtelle, Cal.

IN the opinion of the writer, there is a general misconception of the immediate cause of the phenomena of the semidiurnal oceanic tides. I approach the subject very directly, that its discussion may not extend this paper beyond proper limits.

The usual explanation of the *modus operandi* of the moon's influence is very unsatisfactory to the ordinary inquirer, and especially that part of it which attempts to account for the tidal flow opposite the prolunar side of the earth. Perhaps the failure of the scientific expositors is due to a mistaken impression of how the moon's power is applied. The most important vantage is discarded or neglected. The pulling of the moon upon the waters of the prolunar geohemisphere is assumed to be the main cause of the tidal wave on that side of the earth, the sun coming in as an adjunctive or diversive agency, as the case may be. On the opposite hemispere the marine proturbance results from the unequal pull on the ocean bottom and the ocean surface, or, as some express it, by a pulling away of the land from the waters, "as it were," as a qualifying phrase, which, to use another metaphor, is putting the proposition into a ruminant's paunch for subsequent mastication. It is difficult to conceive the power thus attributed to the moon as really operative, while our senses give no indication of it in our physiological experience. It is still more difficult for the student to mentally perceive how the land and sea are pulled apart on both sides of the globe simultaneously.

I will endeavor to show a cause of tides more powerful than the moon's direct action, and the operation of which can be more easily comprehended, existing within the compass of the earth, and subject to the laws of gravity. The tendency of concrete bodies to approach each other is proportioned to the sum of their masses, modified by the spatial degrees of separation, diminishing as the latter increases, and augmenting as it declines in proportion to the square of any lineal unit or units of measure. That is to say, if their distance apart is doubled, the gravitational force is reduced to one-fourth its previous power; but if the original distance is reduced to one-half, the power is increased fourfold. Now, in spheres, if the mass is distributed symmetrically, the center of

gravity will be the center of the sphere, but if unsymmetrically, the gravity center will be eccentric with reference to the spherical center. The latter relation exists in the moon. But this incoincidence has no dynamic effect in a non-rotating sphere. In a rotating sphere this incoincidence becomes a very important source of dynamic action. The internal mass is constantly impelled to adjust itself symmetrically concentric to the middle point of the axis of rotation. The movements of adjustment engender heat, intense in dense matter, and are continuously and eternally operating while equilibrium is unsatisfied. This a law of gravity, everlasting, invariable, and instantaneous in action. The earth's center of gravity is, therefore, the central point of its axis of rotation.

The ratio of the moon's mass to that of the earth has not been certainly determined, but is assumed to be about as one to eighty, a convenient one to use in this connection. The geolunar gravity center is near the center of the earth. It would be if the two planets were in contact, but by reason of the distance of the eighty-first part from the main mass it is nearer. It is a constantly changing point, and the earth's center revolves about it monthly, at a varying distance regulated by the moon's perigee and apogee positions.

In an old edition of Burritt's Astronomy, a popular work forty to fifty years ago, the geolunar gravity center was placed at about 3000 miles from the earth's center. But this assumed distance seems to have been suggested on the principle of the steelyard. In modern works of astronomy and physics which I have consulted, but little reference to this important focus is to be found. That it must be near the earth's center is evident or the mensal revolution about it would be a very obvious and remarkable phenomenon in astronomical observations. But it is certain that it cannot be coincident or identical with the terrestrial center; if this were the case there would be no tides. Now, this eccentric destroyer of equilibrium cannot be eliminated by any rearrangement of the earth's materials, because it is a continually shifting point westward, northward, southward, centripetally and centrifugally. Yet it is the point towards which all the earth's substances are constantly pressing, keeping up an incessant churning of the fluid interior already under pressures of 2,000,000 to 3,000,000 atmospheres. The heat engendered must be beyond calculation, and it is not extravagant to suppose that gases as dense as metals on the surface mingle according to the law of gaseous diffusion. And yet this heat is not equivalent to what escapes from the surface, as shown

by the continued contraction of the crust. As we go from the center outwards the intensity of influence becomes rapidly less in proportion to the squares of distance from the heart of turbulence. The severity of action in the interior is due to the extreme influence of mass relative to volume from pressure, to the nature of its elements and to the comparatively great differences in distances between the geolunar gravity center and the various parts of the indeterminate core. A little way from this fountain of agitation the ratios of distance are much reduced, and at the surface are quite small. The tides are the last obvious phenomenon, the tail, indeed, of the moon's interference with mundane equilibrium. I say "obvious phenomenon," though, as a matter of fact, the petrosphere is subject to continuous vibrations, discernable at seismographic stations, similar to those affecting the most massive bridges under the strain of footsteps, moving vehicles, and winds. And the atmosphere gives some indications of response to the tumult of the centrosphere, but owing to its elasticity no perceptible movements of its matter can be traced with certainty to that cause.

I will now attempt to make clear the working of the tides, beginning with the aplunar geohemisphere, or that hemisphere farthest from the moon. The point on the surface of the ocean directly in line with the geolunar gravity center and the moon is the highest on the hydrosphere, because it is the most remote from that center. It is common observation that water "runs down hill." No fact in nature is better established as a matter of positive knowledge, and every grammar-school boy can tell why. He knows that all fluids seek a position not occupied by something heavier, nearest the center of gravity, generally regarded as the center of the earth, but really the geolunar gravity center. The flowing fluid is said to be seeking its level. This is what the waters of the ocean do; they seek a level, an equilibrium. In every direction they flow from this high point towards a lower one. If the high point were fixed it would soon vanish, for the water would attain its level and there would be neither high nor low point

Only the westward and the eastward retreat of the waters from the high point need be considered with reference to tidal action in general. The water seeking its level westward exerts its weight contrary to its rotational motion, and the latter is slowed; that seeking its level eastward, in the direction of rotation, accelerates its own velocity. The eastern land coasts of the continental areas with undiminished velocity collide with the west flowing, or retarded, water, and bury themselves in its breast, and this process

produces the tidal phenomenon of the eastern coasts. On the other hand, the accelerated eastern flow, striking the normally moving west coast lands, rushes over them and drowns them in its billows. Thus we have on one side the land plowing into the sea, and on the other the sea overwhelming the land.

Now, let us investigate the situation on the prolunar geohemisphere. Directly under the moon and exactly opposite the high point is the lowest spot on the face of the hydrosphere, which covers nearly three-fourths of the spherical area. It is the lowest because it is the one nearest the geolunar gravity center. It is the one spot toward which all the waters of the hemisphere are flowing in seeking their level. The waters to the west of it, flowing eastward, are the accelerated waters; those to the east, flowing westward, are the retarded waters: but they sustain the same relations to the coast-lines as on the other hemisphere. If we now connect the two hemispheres and trace the tidal sweeps from one to the other we find continuous flows from the high point to the low point, starting in opposite ways. The waters of the ocean are seeking their level precisely as the rivers do; as, for instance, the Sacramento and the San Joaquin, of California, from the northwest and southeast, respectively, find their level in the bay of San Francisco.

It is well known that water does not move as a solid body does—at the same rate of motion throughout its mass—but some parts move swifter than others, the free surface having lesser friction to overcome, and the deeper and denser, the greater, give to the visible current a rolling appearance; hence we habitually and correctly speak of the rolling wave, the rolling river, as "the flow of Isar rolling rapidly." In the tidal wave there is always a thin, wedge-shaped advanced stratum in front of the main mass, and a like stratum lagging at the origin of the flow. We may call the high and the low points described above the tidal poles. It is at these poles that the moving floods are most shallowed, and midway between that they are most thickened. When the poles pass the coasts, or, rather, when the coasts pass the poles, at the velocity of about $14\frac{1}{2}$ degrees an hour, it is the extreme of ebb, and when they pass the midway points it is the acme of flood.

We may now consider the direct influence of the moon upon the earth's surface, without regard to the geolunar gravity center. If the moon's center were within 4000 miles of the earth's surface, the influence of the satellite upon the hydrosphere would be in the ratio of its mass to that of the earth's, and a pound normal of 7000 grains would be diminished in weight about 87 to 88 grains on

that spot of the prolunar hemisphere directly under the satellite; but being 60 times as far distant, its power is but $\frac{1}{3600}$ of what it would be in the assumed position; and if we allow its counterbalancing effect on the normal avoirdupois pound as $\frac{1}{40}$ of a grain, we make a very liberal concession. This is a ratio of 1 to 280,000 compared with the earth's influence in weight making. With this vast difference in degrees of ponderal powers, it seems like the shadow of a metaphor to attribute a capacity to our great sunlight reflector to pull up from the normal level millions of tons of water in opposition to nearly 300,000 times its own potency. But what we speak of as the subtrahend of terrestrial weight, or the pulling force of the moon, is really but an index of the tendency of the water to leave the earth and go to the moon, an impulse inherent in the water itself and not in any extrinsic pulling force, and which, measured by its tendency to remain, is as 1 to 280,000. It is true there must be a differential in degrees of tendency between surface waters and deep layers, but this is too slight to produce an observable effect. If a pulling power would draw the waters toward the eastern shores, it would draw them away from the western shores, and the tides there would be but the effect of their returning to the normal. It may be possible to measure mechanically with a torsion fiber and a long index finger over a large dial the supposed power of the moon. I am not aware that the attempt has been made. It would be a great triumph of skill and science, if successful.

Yet in that case how could the effect of the approach of the geolunar gravity center to the sublunar terrestrial surface be excluded from the elements entering into the difficult experiment and its results? Unfortunately the dynamics of the tides have been made a datum for calculating the moon's mass, with a likelihood of having derived too large a quantity as a conclusion. It is quite possible, if not probable, that its ratio of mass to that of the earth's is not even 1 to 100, instead of 1 to 80. If the satellite is an offspring of the earth, which appears a very proper inference from what we know of cosmic physics of solar action and extraplanetary conditions, it was born when our globe had a gaseous or liquid constitution from center to circumference, and was much more oblate than at present, and must be mostly composed of the lightest metals and metalloids. Nor is it probable that since that time it has ever enlarged its orbital circuit—on the contrary, it is more likely to have contracted it, for reasons which are given in another paper.

The action of the sun in gravity work is all direct, for the geo-solar gravity center is in the body of that governing fire-ball, and so of all the intra-Jovian planets, and, probably, of all the others. It may be that the planets themselves are responsible for much of the heat they receive from the sun, for the numerous eccentric gravity centers in that revolving and rotating star must cause an agitation and disruption of its entire constitution, with evolution of heat. This is no fanciful conjecture of what *may* be, but a certain result of admitted gravitational law.

Turning to the question of the moon's influence to affect the length of the siderial day, we have seen that the tides are mainly caused by the eccentricity of the geolunar gravity center to the purely terrestial center and the axis of rotation, and to rotation itself, and that the moon's direct influence is simply a slight abatement or augmentation, as the case may be, of the normal weight of terrestrial matter; in either case producing no result not offset by a counter result. Unless it can be shown that purely secular re-distributions of matter, such as come from trade-winds and ocean currents, have an effect to check rotational velocity, we may dismiss the idea that the moon does.

The premises and chief corollaries of the theorem may be summed up in the following propositions:

The geolunar gravity center is the point which all the matter of the earth presses to attain.

It is eccentric to the axis of rotation and to the earth's center of gravity.

It is a constantly shifting point, thereby causing a perpetual churning of the earth's fluid or plastic matter in its efforts to distribute its masses in equilibrium concentric to it, evolving heat.

It affects the fluids of the exterior less than those of the interior, conformable to the second Newtonian law of gravitation.

The oceanic tides result from the same influences that cause the interior clash, and are essentially waterfalls of vast extent, intercepted by sections of solid crust above or slightly below the normal sea surface.

The direct influence of the moon only feebly effects the normal ponderal relations of terrestrial matter, and does not retard terrestrial rotation.

The solid, brittle upper strata of the earth's crust, lined below by the semiplastic and plastic cushions of mixed material, are affected to continuous vibrations of very mild degrees.

A concluding thought is this: We are indebted to the moon for

a habitable globe to-day. Without its existence as a heat producer in disturbing subterrranean tranquillity, the earth ere this would have become a cold, solid, asymetrical, non-rotating spheroid. It is impossible that a large composite body of fluid become solid from loss of heat and retain symmetrical distribution of mass about its center of figure. Some parts or segments of the same radial distance from the center, and in the same plane parallel to the equator, will cool sooner than the remaining segments similarly situated, and from various causes, and asymmetry will follow. With asymmetry and complete solidity rotation must cease, as in the cases of Mercury, Venus, the moons, and the asteroids. Wherever we find a planet with a moon, or with moons, we may infer a rotation and a fluid interior, and with moonless planets the absence of both.

THE SPECTRUM AND SPECTRUM SCALES.

By J. T. Lovewell, Topeka, Kan.

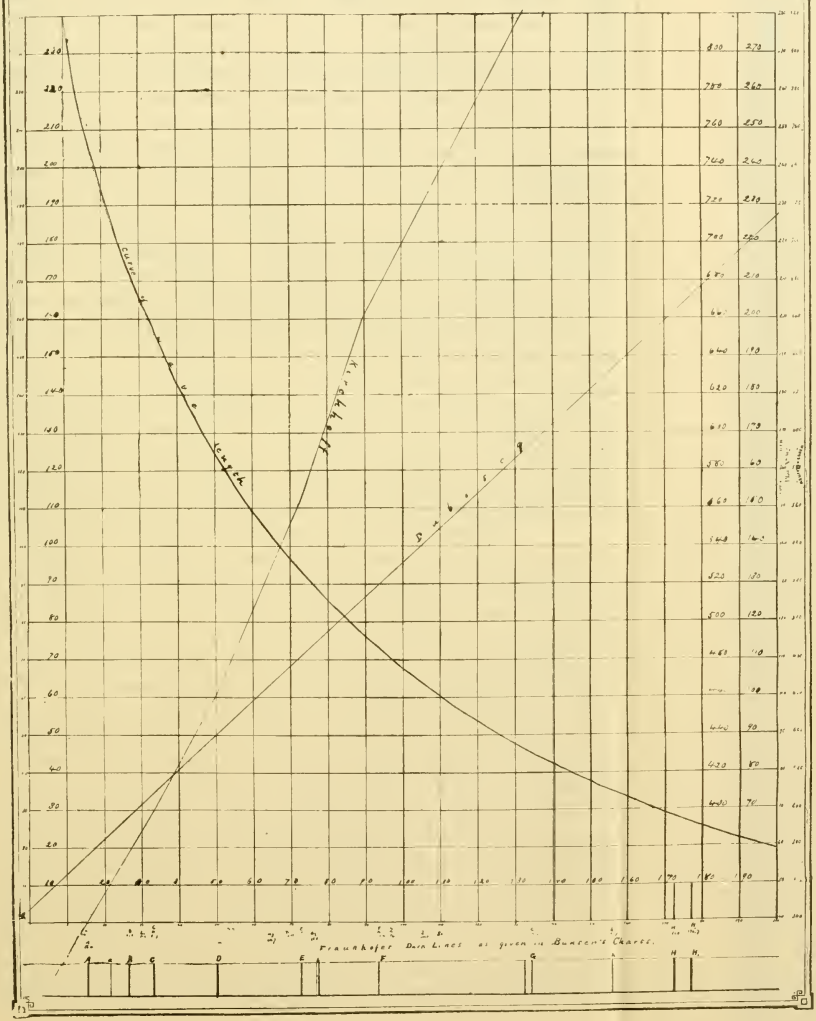
IN the ordinary laboratory spectroscope we may often observe a line which we wish to compare, for identification, with numbers in the tables of Kirchhoff, or with wave-lengths as given in Angstrom's and similar charts. Perfect agreement of readings cannot be expected in different refraction spectroscopes, where lines are designated either by the angle of deviation or by the number of a photographed scale, which is brought into the field of view with the spectrum. Every prism has its own problem of refraction, and every photographed scale must have imperfections. In the diagram herewith presented use is made of curves, which are now employed in the discussion of so many physical problems. The spectroscope with which observations were made was a Duboscq single-prism instrument, with the ordinary photographed scale reflected into the field of the observing telescope. The scale numbers were from 1 to 200, and the first problem was to compare these with the numbers of Bunsen's charts of flame spectra. On a sheet of cross-section paper, ruled in inches and tenths, the lower margin was marked with the Bunsen chart numbers, which were to be the abscissas of the proposed curve. A few of the Fraunhofer lines of the solar spectrum are drawn in the margin as given in Bunsen's charts. For ordinates of the curve, readings of the spectroscope were used; for solar lines and for a great variety of flame spectral lines, obtained from soluble salts of metals, brought into the flame of a Bunsen lamp. The scale number of the observed line forms the ordinate of the curve, and these numbers are placed on the left-hand margin of the chart. The scale was adjusted so that the number 50 coincided with the sodium line or the Fraunhofer D line of the solar spectrum. The abscissas and ordinates of a large number of points in all parts of the spectrum were next found, and through the mean position of these points a curve was drawn which proved to be practically a straight line. Had the spectroscope employed by Bunsen been exactly like the one used here this line would have been at an angle of 45 degrees, but it was found to have an angle less than that, measured from the horizontal.

The Bunsen and Duboscq scales were supposed to be alike, as were also the prisms, but 50, the number to which they were adjusted, is the only point of exact coincidence where the lines cross.

When the Bunsen line of 160 is examined, the Duboscq number is 150. Drawn on the original scale the Duboscq curve is not quite a straight line, but has slight deviations, which are not noticeable when reduced to one-fourth the size, as in the diagram accompanying this paper. By the aid of this curve any observed line may at once be compared with the Bunsen charts. In a like manner a curve from Kirchhoff's scale numbers is prepared, only in this case the spectrum lines were obtained from the electric spark. It was by this means that Kirchhoff obtained most of his numbers. His spectroscope contained four prisms of flint glass, three of which had a reflecting angle of 45 degrees and the fourth an angle of 60 degrees. These were mounted on metallic stands with leveling screws, and suitably placed on a circular iron plate, upon the rim of which the telescopes were clamped. The light for the metallic spectra was obtained by three or four Bunsen elements acting on a large Ruhmkorff induction coil. A heliostat directed the solar rays upon the object-glass of his collimator, and his first care was to represent the lines of the solar spectrum as faithfully as possible, as they appeared in his spectroscope. The distance apart of the lines was measured by movement of an arm which was attached to the observing telescope, and this movement was estimated by the divided circle, with a micrometer screw attached. Record was made of the lines on a chart by means of a kind of equal-part machine, and the intensity and breadth of the lines were shown, the former by three shades of ink. Above the spectrum as thus exhibited he placed a millimeter scale, with a starting-point selected at pleasure. He chose such a position as brought the D line very near the 100 mark on the scale. After the solar spectrum was thus recorded, Kirchhoff proceeded to find the places of the metallic spectral lines as compared with the dark solar lines. To accomplish this he observed simultaneous spectra of the sun and of the metals. The solar beam was received into the upper half of the slit, and the metallic rays into the lower half, first falling on a glass prism so placed over the lower part of the slit that the ray, after a twofold total reflection, fell into the field desired.

The results of these observations were recorded with the same care as the former, and both were repeated until satisfactory agreement was obtained. Kirchhoff observed that a great difference resulted in the appearance of the lines as the temperature changed and as other vapors were present. Angstrom denies that there is any real change in the position of the lines, and takes issue with Plucker on this point. Kirchhoff's observations extended from

CURVES OF WAVE LENGTH



the line D to somewhat beyond the line F, and his pupil and assistant, Hofmann, with the same apparatus and by the same methods, observed and mapped the rest of the spectrum from a little below A to a little beyond G. From the result of their labors we have what are commonly referred to as Kirchhoff numbers. Thalen with different instruments subsequently extended this scale to H. The Kirchhoff scale numbers are given in the right-hand margin of the diagram, and with these as ordinates, and the same abscissas before used, the Kirchhoff curve is drawn; and by comparing its ordinates with those having the same abscissa on the Duboscq curve, the identity of any metallic line seen by the Duboscq instrument may be established. The most exact designation of spectrum lines is doubtless by wave-lengths. The Swedish physicist, Angstrom, reduced the Kirchhoff numbers to wave-lengths, as well as greatly extended his observations, and the numbers taken from his charts are the abscissas in the wave-length curve here shown. The unit is one divided by 10 seventh power, expressed in millimeters, decimally 0.00000001 mm. It will be seen that the curve is tolerably regular and convex from the axis of abscissas. The wave-lengths are given in the right-hand margin, from 400 to 800 in units, as above indicated. We may thus find in any observation in this single-prism spectroscope the corresponding Bunsen chart numbers, the Kirchhoff numbers, or the wave-lengths.

Wollaston, in 1802, appears to have been the first to observe the dark lines in the solar spectrum which are always produced if the light falling on the refracting prism issues from a narrow slit parallel to the axis of the prism instead of a circular aperture, as in Newton's experiments. These lines were not carefully studied till 1814, when Fraunhofer, a celebrated Munich optician, took up the subject and carefully studied these lines. He designated seven different lines or groups of lines by the first seven letters of the alphabet, which continue to be the common names of these lines. He counted in the spectrum, obtained by his instruments, 574 lines. He devised a grating, made by winding fine platinum wire on the threads of two parallel screws, soldering the wire to them, and then cutting the wire away on one side. Letting his narrow beam of solar light fall on this grating, and making use of the principle of interference developed by Young, Arago, and Fresnel, he was able to measure the wave-lengths of many of these dark lines. It was not, however, till 1860 that Kirchhoff, by a splendid induction, explained the cause of these dark lines and demonstrated that the

spectroscope not only showed the constitution of earthly bodies, but could analyze the sun and stars.

No limit has been found in the number of solar lines, nor are they confined to the visible spectrum. Photography comes to our aid in studying the invisible spectrum, especially of the violet end. Wonderful improvements have also been made in the manner of obtaining the spectrum. In place of the grating of fine wires devised by Fraunhofer rulings are made on speculum metal with as many as 20,000 lines to the inch, by which the spectrum is spread out to twelve feet or more. These photographic charts far surpass the best results of Kirchhoff and Angstrom. In the chemical laboratory, however, the refraction spectroscope must remain the common instrument, and the method of curves herewith presented will be found a useful adjunct to its use.

THE QUANTITATIVE ESTIMATION OF IRON AND COBALT BY THE ROTATING CATHODE.

By R. W. Curtis and S. A. McReynolds.

THE application of a rotating cathode to the analytical determination of metals by electrolysis was introduced by Gooch in 1903, and the form of apparatus devised, and experiments with the same, are described in several papers from his laboratory.*

Mention is made that a rotating cathode had already been used in the arts for the purpose of securing compact metallic deposits in electroplating.

Soon after the appearance of the first paper the use of a rotating anode for a similar purpose was described by Exner.†

The apparatus used by Gooch and Medway consisted of a small electric motor to the shaft of which, running in a vertical position, was fastened a rubber stopper. An ordinary platinum crucible was slipped on the stopper, electrical contact being made through a strip of platinum connecting with the shaft. A beaker containing the solution to be electrolyzed was raised upon a suitable standard until the crucible was immersed to within eight or nine millimeters of the edge. For anode a piece of platinum foil hung upon the inside of the beaker was used.

The crucible serving as cathode was revolved from 600 to 800 revolutions a minute. The current varied from 0.8 to 4.0 amperes, the corresponding current density per 100 sq. cm. being from 2.7 to 13.3. The time required for a determination was greatly diminished compared with that required in former electrolytic methods in which the ordinary stationary electrodes are used, being, in the case of copper, fifteen minutes on the average, zinc thirty minutes, etc. The results for a large number of experiments shown left nothing to be desired, varying in most cases but one- or two-tenths of a milligram from the correct values.

The metals experimented with, the results of which are shown in the above papers referred to, are copper, silver, nickel, cadmium, tin, zinc, and gold.

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* Gooch and Medway, Am. Jour. Sci., XV, 320 (1903). Medway, ib., XVIII, 56, 180 (1904), and Zen. amorg. Chem. 35, 414, etc.

† Exner, Jour. Am. Chem. Soc., XXV, 806 (1903).

The experiments reported herewith were carried out with apparatus quite similar to that described above. Copper was first tried, to show whether or not the right conditions had been secured. A solution of copper sulfate several times recrystallized was made, and standardized gravimetrically by a number of closely agreeing determinations made by precipitation with sodium carbonate, igniting and weighing the copper as copper oxid. The results and details are shown in table I. The solution to be electrolyzed was acidified with twelve drops of sulfuric acid 1:4, and occupied a volume of 65 cc.

TABLE I. Copper.

No.	$CuSO_4$ taken, cc.	Current, amp.	N. D., 100.	Speed per min.	Time, min.	Cu taken, gm.	Cu found, gm.	Error, gm.
1.....	20 00	1 5	8 9	687	15	0 1110	0 1116	+0 0006
2.....	20.00	1.5	8.9	687	15	0 1110	0.1112	+0.0002
3.....	20 00	1 5	8.9	775	15	0.1110	0 1117	+0 0007
4.....	20 00	1 5	8 9	750	15	0.1110	0.1110	±0.0000
5.....	20.00	1.5	8.9	750	15	0.1110	0.1111	+0.0001
6.....	20.00	1.5	8.9	812	15	0.1110	0.1110	±0.0000
7.....	20 00	1.5	8 9	775	15	0.1110	0.1111	+0.0001
8.....	20 00	1.5	8 9	800	15	0 1110	0.1110	±0.0000
9.....	*30.00	1 5	8 9	1,000	8	0.0760	0.0760	±0.0000
10	25 00	1 5	8.9	875	15	0.0634	0.0634	±0 0000
11.....	25 00	2 2	13.1	800	15	0.0634	0 0635	+0 0001
12.....	25.00	2 7	16.1	850	15	0 0634	0.0634	±0 0000
13	25.00	3 0	17.9	825	15	0 0634	0.0635	+0 0001
14.....	25 00	2 8	16.7	850	10	0.0634	0.0634	±0 0000

*A new standard solution made up.

The salt used for the estimating of iron was ferrous ammonium sulfate in ammonium oxalate sulution, 1:6, 50 cc After running for ten minutes the motor was stopped and the sides of the beaker were washed down, as was done with all the experiments with the rotating cathode. It was found that great care was needed in drying the deposit on the crucible by dipping in water, then in alcohol, and holding over a low flame of a Bunsen burner. The deposit was removed by dipping in concentrated hydrochloric acid for a few seconds, and came off in flakes. The completeness of the deposition may be tested at any time toward the end, by removing a drop of the solution, acidifying with hydrochloric acid, and adding potassium sulfocyanide. The results are given in table II.

TABLE II. Iron.

No.	Ferrous am. sulf. taken, gm.	Current, amp.	N. D., 100.	Speed.	Time, min.	Iron taken, gm.	Iron found, gm.	Error, gm.
1	0.4384	2.0	11.9	800	15	0.0625	0.0631	+0.0006
2.....	0.4000	2.9	17.3	800	15	0.0561	0.0563	+0.0002
3.....	0.4000	2.8	16.7	800	18	0.0561	0.0550	−0.0011
4.....	0.4000	2.6	15.5	800	18	0.0561	0.0561	±0.0000
5.....	0.4000	2.1	12.5	800	18	0.0561	0.0563	+0.0002
6.....	0.4000	2.1	12.5	800	20	0.0561	0.0560	−0.0001
7.....	0.4000	2.1	12.5	800	20	0.0561	0.0561	±0.0000
8.....	0.4000	2.2	13.1	750	20	0.0561	0.0563	+0.0002
9.....	0.4000	2 1	12.5	775	20	0.0561	0.0561	±0.0000
10.....	0.4000	2.9	17.3	800	15	0.0561	0.0563	+0.0002

For experiments in the estimation of cobalt the nitrate was used, the solution being standardized by conversion to the oxid and reducing in a Rose crucible with hydrogen. The results follow:

TABLE III. Cobalt.

No.	Cobalt nitrate sol. taken, cc.	Ammonium oxalate, gm.	Current, amp.	N. D., 100.	Speed.	Time, min.	Cobalt taken, gm.	Cobalt found, gm.	Error.
1	25.00	2.5	2.0	11 9	800	32	.....	Lost.	.....
2	25.00	2.0	2.0	11 9	800	35	.....	Lost.	.....
3	25.00	2.0	2 0	11.9	800	32	.....	Lost.	.....
4	25.00	2.0	2 0	11 9	800	35	0.0600	0 0597	−0.0003
5	25 00	2.0	3 0	17 9	800	30	0 0600	0.0598	−0.0002
6	25.00	2 0	2.4	14 3	800	35	0 0600	0 0598	−0.0002
7	25.00	2.0	2.4	14 3	800	33	0.0600	0.0599	−0 0001
8	25 00	2.0	2.5	14.9	800	35	0.0600	0 0605	+0 0005
9	25.00	2.0	2.5	14 9	800	30	0 0600	0.0588	−0.0012
10	25.00	2 0	2 8	16 7	850	25	0.0600	0 0599	−0 0001

These results indicate that, as was to be expected, the application of this method may be extended to include the determination of other metals, and must prove a valuable addition to the processes at the disposal of the analytical chemist on account of its accuracy and rapidity.

We wish to express thanks to Prof. E. H. S. Bailey for interest and encouragement, and to Dr. H. P. Cady for helpful suggestions and the loan of apparatus.

NOTES ON KANSAS ROAD METAL.

By F. O. MARVIN, University of Kansas, Lawrence.

LAST year, Mr. N. M. McGillivray and Mr. E. H. Dunmire, seniors of the school of engineering of the University of Kansas, undertook an investigation of the various kinds of stone in the eastern part of the state to determine their relative value for the making of good roads. The work was carried on through the year, and an abstract of the results is hereby given.

The road laboratory is equipped with a Deval machine for testing resistance to impact and abrasion, a battery of Abbe flint-jar mills for fine grinding, a hydraulic press for making briquets from the fine dust, a Page cementation machine for breaking these briquets, and an apparatus for the freezing test. The collection of the stone was largely due to the aid of Professor Haworth, of the the Geological Survey.

The methods followed in making the tests were in the main those used by the road laboratory of the United States government. The Deval machine consists of a battery of four iron cylinders, 20 centimeters in diameter and 34 centimeters in length, set at 30 degrees to the axis of revolution. In each is placed five kilograms of dried stone broken to a standard size, to pass a six-centimeter ring and returned on a three-centimeter one. The cylinders are then closed with an air-tight cover and rotated at the rate of $33\frac{1}{3}$ revolutions per minute for a total of 10,000 revolutions. The per cent. of loss of weight caused by this action is taken as representing the value of the materials tested to resist impact and abrasion. The lower this per cent. the better the stone. In French practice it was found that the best stone for road purposes lost about 20 grams per kilogram, or two per cent. This figure 20 then was fixed as a standard of excellence and a formula $\frac{20 \times 20}{W}$ adopted as a coefficient to represent the comparative value of various stone, W being the weight in grams per kilogram of the loss in the Deval machine. The larger this coefficient the better the stone. This test has been standardized and adopted as being the best index of a stone value yet devised, although not alone conclusive.

The cementation test is designed to bring out a stone's cementing and binding power. For this, one kilogram of stone broken to small pieces is ground up to very fine dust in the porcelain jar

pebble mill. This dust, sifted through No. 7 bolting cloth, is mixed with water into a stiff dough, allowed to stand for twenty-four hours in tight jars, and then pressed by hydraulic power, with a maximum of 100 kilograms per square centimeter (1400 pounds per square inch), into cylinders one inch high and one inch in diameter (2.5 centimeters). These are oven-dried for twenty-four hours and then broken by blows in the Page machine. The blows are given by a one kilogram (2.2 pounds) rain falling a distance of one centimeter, the number of blows needed to fracture the briquet being taken to represent the cementing power of the material. Five briquets were tested for each sample. This test is of great value, but the methods of making it have not as yet been worked out with entire satisfaction. An impact test of a rain, falling in a small machine like a pile-driver on a small block cut from the actual stone, is often made, but this is not included in this series.

In the freezing and thawing tests, ten pieces of the stone to be tested were first dried thoroughly, then saturated, and frozen by being placed in the open air. When the temperature fell to 20 degrees F. or lower, the stone was considered sufficiently frozen. The stone was then thawed by steam, resaturated, and again frozen. After as many alternate freezings and thawings as would be obtained last winter, the loss of weight was determined. Also the stone that had been subjected to this process was put through the Deval machine and its loss by abrasion compared with that of unfrozen samples. The results have not been very satisfactory, because of the limited cold weather of last winter, the insufficient number of tests, and the experimental stage of the matter. On all samples tested there was a slight loss, due to freezing and thawing, varying from 0.28 per cent. to 1.25 per cent. The Deval test on stone subjected to the freezing test showed a loss sometimes larger and sometimes smaller than that from untreated stone. It is likely that the test may prove of some value, but there has been too little work done to warrant any conclusions.

Determinations of weight, specific gravity, porosity and absorption were also made.

Following is a table showing the results of the tests of the years 1905–'06:

TESTS OF KANSAS STONE AS TO VALUE FOR ROAD MAKING.

LIMESTONES.

Number	Location.	Geological name of stratum.	Loss; abrasion and impact	French coefficient.	Specific gravity	Porosity	Absorption	Loss by freezing test	Number of blows, cementation test
1	McCune	Fort Scott	3.67%	10.9%	2.69	0.89%	1.46%		
2	Coffeyville	Coffeyville	5.07	7.9	2.68	0.52	0.87		
3	Chanute	Iola	4.29	9.3	2.69	0.54	0.90		
4	Iola	"	9.38	4.3	2.66	3.36	5.13		
5	Osawatomie	"	4.25	9.4	2.70	0.02	0.04		
6	"	"	5.41	7.4	2.68	0.80	1.31		
7	Rosedale	"	5.36	7.4	2.85	2.68	4.43		
8	Argentine	Silicious	4.66	8.8	2.67	0.48	0.78		
9	"	Iola	5.69	7.0	2.71	0.32	0.32		
10	Garnett	Stanton	3.40	13.0	2.68	0.48	0.79		
11	Ottawa	"	5.62	7.1	2.64	1.42	2.26		
12	"	"	4.54	8.8	2.69	0.54	0.89		
13	"	"	5.94	6.7	2.67	2.22	3.49		
14	"	"	4.91	8.2	2.72	0.69	2.72		
15	Leavenworth	"	4.93	8.9	2.45	1.22	1.99		
16	"	Oread	7.00	6.1	2.59	2.48	3.77		
17	Lawrence	Kickapoo	4.55	8.8	2.68 2.67	1.40 1.08	2.26 1.75	0.44%	46
18	"	Oread	4.32	9.3	2.64	0.62	1.01	0.28	8
19	"	"	4.21	9.5	2.66	1.89	2.99	0.54	
20	"	"	5.91	6.8	2.72	3.16	4.95	0.42	
21	Williamsburg	"	5.82	6.9	2.59	2.26	3.44		
22	"	"	3.69	10.8	2.72	0.76	1.17		
23	Atchison	"	9.41	4.6	2.57	1.99	3.03	0.45	35
24	"	Lecompton	5.75	7.2	2.66	1.50	2.41		
25	Jefferson co	"	6.06	7.4	2.61	2.29	3.53	0.33	10
26	Oskaloosa	Deer Creek	4.45	9.0	2.67	1.08	1.75		
27	"	"	5.59	6.9	2.59	1.09	1.72		
28	Tevis	"	4.58	8.7	2.67	0.58	0.95	0.75	5
29	Valley Falls	Topeka	4.15	9.7	2.69	0.58	0.97		
30	"	"	6.12	6.7	2.68	1.09	1.77		
31	"	"	6.03	6.7	2.68	2.10	3.34		
32	Muscotah	Burlingame	3.58	11.4	2.69	1.60	2.58		
33	"	Wabaunsee	3.13	12.9	2.71	0.71	1.17		
34	Americus	Thin stratum	7.51	5.5	2.59	1.79	2.76	1.19	131
35	Americus	Americus	14.92	2.9	2.59	3.02	4.53		
36	Allen	Thin stratum	4.74	8.5	2.69	1.23	2.07	0.59	49
37	"	Americus	6.13	6.4	2.59	3.95	5.81		
38	Dunlap	Cottonwood Falls	8.71	4.6	2.72	2.05	3.32		64
39	Holton	Wabaunsee	5.15	7.9	2.59	2.29	3.50		
40	Soldier	"	6.25	6.6	2.58	2.63	3.97		
41	Seneca	"	6.03	7.3	2.63	1.30	2.09		
42	Frankfort	"	5.43	7.5	2.37				
43	"	"	4.50	10.5	2.48	1.53	2.28		
44	"	"	6.73	6.0	2.62	3.08	4.66		
45	"	"	9.27	4.3	2.54	3.76	5.47		
46	"	Cottonwood Falls	8.85	4.5	2.54	1.91	2.89		
47	Helmick		16.73	2.4	2.38	4.13	5.84	0.67	32
48	Dwight		30.08	1.3	2.31	2.05	2.83	0.84	12
49	Junction City	Fort Riley	14.92	2.9	2.50	5.62	7.74	0.73	19
50	Silverdale		20.55	2.0	2.58	5.73	8.05	0.28	
51	El Dorado		6.77	6.0	2.64	8.31	11.21	1.25	220
52	Marion	Marion	15.24	2.8	2.67	8.71	11.80		

CHERT.

53	Alta Vista	Cherty lines	10.51	3.8	2.62	3.14	4.75	0.92	38
54	Galena	Joplin flint	3.66	10.9	2.37	5.86	7.32		4

SANDSTONE AND DRIFT.

55	Redfield	Bandera sandstone	7.81	5.1	2.60	3.09	4.66		49
56	Lawrence	Drift boulders	2.22	22.2	2.64	0.03	0.05		
57	"	"	2.54	15.8	2.66	0.09	0.16		
58	"	"	1.51	26.6	2.40	0.09	0.15		

PAVING BRICK, FOR COMPARISON.

59	Coffeyville		5.40	7.4	2.44	1.50	2.21		

An examination of results shows that the farther west one goes the softer, lighter and more absorbent the rocks become, that the cementing value cannot be inferred from external appearance or from the results of other tests. Much more work is needed, as the present series is not extended sufficiently to warrant drawing definite conclusions.

If the results of the Deval test are taken as an index of relative value and expressed by means of the French coefficient, the best stone examined in this series ranges as follows:

No. 10....	Garnett, Anderson county	13.00
No. 30....	Muscotah, Atchison county	12.85
No. 33....	Muscotah, Atchison county	11.40
No. 1....	McCune, Crawford county	10.90
No. 21....	Williamsburg, Franklin county	10.80
No. 43....	Frankfort, Marshall county	10.45
No. 29....	Valley Falls, Jefferson county	9.65
No. 19....	Lawrence, Douglas county	9.50
No. 5....	Osawatomie, Miami county	9.40
No. 3....	Chanute, Neosho county	9 30
No. 18....	Lawrence, Douglas county	9 30

As to the rank of our limestones as compared with those of other sections, again using the Deval test as a basis, the following figures may be given: Thirty-five Maryland samples gave an average coefficient of 9.34; twelve Massachusetts samples, 10 4; thirty-three samples from all over the United States, 6.51; the fifty-two samples of this series from Kansas, 7.16. Leaving out the softer from Morris, Geary, and adjoining sections, the results would compare favorably with the above figures.

This investigation of Kansas stone for Kansas roads is being continued this year, and it is hoped to obtain more data and larger results.

DEVELOPMENT OF THE FOREST BELTS IN THE NORTHWESTERN PART OF CLAY COUNTY, KANSAS.

By JOHN H. SCHAFFNER, Columbus, Ohio.

THE development of forest belts in the northwestern part of Clay county is confined to the bottom lands and bluffs along the Republican river and its tributary creeks. The two main creek systems are Mulberry creek and Five creeks, the sources of both being to the west, in the eastern part of Cloud county. These creeks and their branches lie for the most part in Mulberry, Bloom and Five Creeks townships.

The rocks in the region belong to the Dakota group, except toward the southeast, where the upper part of the Permian limestone begins to outcrop. The soil is thus decidedly sandy, on account of the great abundance of Dakota sandstone, although clays are also abundant. The character of the soil seems to have some influence on the distribution of certain trees and shrubs, for a number of species flourish across the line in the Permian limestone region which are not found in the Dakota.

The Republican river has a wide flood-plain, and in some places the timber belts extend outward a quarter of a mile, though usually much narrower. The woody plants in the river valley in Bloom and Mulberry townships are as follows:

TREES.

Salix amygdaloides Anders.
Salix missouriensis Bebb.
Populus deltoides Marsh.
Juglans nigra L.
Ulmus fulva Mx.
Celtis occidentalis Mx.
Morus rubra L.
Cercis canadensis L.
Gleditschia triacanthos L.
Gymnocladus dioica (L.) Koch.
Acer negundo L.
Fraxinus lanceolata Borck.

Farther down the river valley *Quercus macrocarpa* Mx. is abundant, but it seems to be practically limited to the Permian outcrops in this region. *Salix nigra* Marsh. may occur also, since it was found in Ottawa county, which joins Clay on the southwest.

SHRUBS AND SHRUB-LIKE TREES.

Salix cordata Muhl.
Salix fluviatilis Nutt.
Ribes missouriensis Nutt.
Rosa arkansana Porter.
Rubus occidentalis L.
Prunus americana Marsh.
Prunus watsoni Sarg.
Amorpha fruticosa L.
Amorpha canescens Pursh.
Euonymus atropurpureus Jacq.
Rhus glabra L.
Cornus asperifolia Mx.
Sambucus canadensis L.
Symphoricarpos symphoricarpos (L.) MacM.
Symphoricarpos racemosus Mx.
Cephalanthus occidentalis L.

In passing up the creek valleys, one meets another shrub, *Prunus virginiana* L. *Rosa arkansana* and *Amorpha canescens* are more properly prairie plants, but invade the forest belt to some extent. All of these shrubs are found in the creek valleys to nearly the upper limit of tree growth, except *Cephalanthus Prunus watsoni*, and *Euonymus*.

LIANAS.

Smilax hispida Muhl.
Clematis missouriensis Rydb.
Menispermum canadense L.
Rhus radicans L.
Celastrus scandens L.
Vitis vulpina L.
Parthenacissus quinquefolia (L.) Planch.

Along Mulberry creek the continuous forest belt ceases about five miles west of its mouth, while the discontinuous belts extend about four miles farther. In passing up the creek valley the five typical trees are box-elder, Green ash, White elm, Honey-locust, and hackberry. Along these are occasional cottonwoods, Peach-leaf willows, or Red mulberries. The Green ash is the first to disappear, usually several miles before the discontinuous forest belt ceases. The remaining four species extend to the limit of tree growth, with an occasional cottonwood or Peach-leaf willow. Half a mile beyond the river belt not an individual, young or old, was seen of the following species: Black walnut, Slippery elm, redbud and coffee-bean. Near the upper limits of the creek the banks are lined with *Amorpha fruticosa* and occasional clumps of Peach-leaf willows. The Poison ivy is the most aggressive of the lianas and extends to the very limits of shrubs and tree growth.

The conditions on Five Creeks are practically the same. North creek, which is a prominent tributary, extends through the southern part of Bloom township. The Green ash is the least progressive up stream of the five typical trees. As one passes near the limits of the continuous forest belt the box-elder is the most abundant, with White elm, Honey-locust, hackberry, Peach-leaf willow, and cottonwood, in about the order named. The shrubs and lianas are similar to those on Mulberry creek. At the upper end of the creek, most of the woody plants are on the steep grassless bluffs, especially on those facing the north. At the mouth of the Five Creeks, which is on the border of the limestone region, the following trees are present:

Salix amygdaloides Anders.
Populus deltoides Marsh.
Juglans nigra L.
Ulmus americana L.
Ulmus fulva Mx.
Celtis occidentalis Mx.
Morus rubra L.
Gleditschia triacanthos L.
Gymocladus dioica (L.) Koch.
Acer negundo L.
Fraxinus lanceolata Borak.
Quercus macrocarpa Mx.

The shrubs and lianas are identical with those at the mouth of Mulberry creek. The only peculiar species, therefore, is the Burr oak. The Burr oak, coffee-bean and Black walnut extend up the creek for several miles, about one-third the distance of the wooded part. The other trees and shrubs begin to disappear in about the same order as on Mulberry and North creeks.

In the southwestern part of the country there are more of the characteristic Eastern trees, as the sycamore, Prickly ash, Red juniper, hickory, and a number of oaks. In the northeastern corner the buckeye and bladdernut are present. In passing westward through the northern part of the state the forest belts are of the same character as those on the two small creeks under discussion. At Jennings, in Decatur county, I found about the same creek flora. Only about a mile of Prairie Dog creek was studied; so the woody flora may not be quite complete for the region, but the list shows the striking similarity of the two localities, although there is a decided difference in the herbaceous plants. The following woody plants were observed:

TREES.	SHRUBS.
Salix amygdaloides Anders.	Salix fluviatilis Nutt.
Populus deltoides Marsh.	Ribes aureum Pursh.
Ulmus americana L.	Rosa arkansana Porter.
Celtis occidentalis L.	Prunus americana Marsh.
Gleditschia triacanthos L.	Amorpha fruticosa L.
Acer negundo L.	Rhus aromatica Ait.
Fraxinus lanceolata Borak.	Symphoricarpos occidentalis Hook.

LIANAS.

Vitis vulpina L.

The upland of Clay county is not adapted to tree growth naturally. The prairie is a true climatic prairie. Trees like the cottonwood frequently die in about twenty years on the high upland if left to themselves. Box-elders and Black walnut also will not thrive. But in ravines and in creeks and river-bottoms conditions are favorable for abundant tree development if once a stand is secured and the ground is not pastured or burned over by prairie fires. But, because of the prevalence of fires, up to thirty years ago the bottoms were not covered by a forest, except narrow and usually interrupted and comparatively short-lived belts along the banks of the streams. Since the forest belts could not progress outward into the prairie, they were as continually cut away by the meandering of the streams as they were developed. At the present time the timber belts along both the rivers and creeks are progressing outward wherever natural conditions prevail. The writer knows

personally of many forest belts which have traveled outward for a considerable distance in the last twenty years. The same is true of the development of wooded bluffs.

The origin of the different types of forest belts and patches may be considered under the following heads: (1) The river-bottom; (2) the creek bottom; (3) the wooded bluff; (4) the ravine.

The River-bottom.—The main development of forest in the river valley is along advancing sand-bars. On the inner side of the river bends the low bar is often overflowed and covered with a rich sediment. On the edge of the bar, above the river-bed proper, there usually grows up a belt of Sand-bar willow (*Salix fluviatilis*) which often travels forward at about the same rate as the bar advances. The roots of this willow spread out beneath the surface of the sand and send out numerous shoots, so that a very close thicket is formed. The Sand-bar willow soon dies, but in the meantime it is replaced by the Peach-leaf willow, and finally by the cottonwood. The cottonwood forest is the normal river-bend forest, and is gradually replaced by the other trees of the river valley which form the culmination flood-plain forest of the region. These trees are as follows: Black walnut, White and Slippery elm, hackberry, Red mulberry, redbud, coffee-bean, Honey-locust, and Green ash. In an old forest which has gone through the normal development, the trees enumerated above make up the bulk of the individuals, with here and there an isolated giant cottonwood, which has escaped destruction.

Sand-hills and ridges blown up by the wind support but a thin stand of grass and other herbs, and in the blowouts and on the newly formed ridges several shrubs, which are forest forerunners, gain a foothold. The most important shrubs are *Prunus watsoni* and *Prunus americana*. Usually the first trees to come in are Honey-locusts, coffee-beans, and, in the deep blowouts, cottonwoods.

Ravines opening into low river-bottoms sometimes lose their channel before reaching the stream, and the soil thus covered with sediment gives rise to a moist-ground forest. The first important trees and shrubs are Sand-bar willow, Peach-leaf willow, and in the lower places *Cephalanthus*. Finally White Elm, Green ash, Black walnut and other trees take possession, and a normal forest is produced.

Cut-off river meanders also frequently give rise to forests. The old channel is gradually filled up with mud and sand, and, where

water is absent, willows, cottonwoods and other trees soon take possession of the river-bed and its banks.

The river-bottoms are inhabited by great numbers of gophers. These throw up small mounds of earth, sometimes several yards in diameter. Here seeds of trees sprout and a forest results. Formerly the fire prevented much development of this type of forest. But at present gopher hills are a very important factor in the out extension of the forest belts. The Green ash is most aggressive in taking possession of these hills. Rough-leaf dogwood is also important. I know of a number of young forests which have developed in this way since prairie fires have ceased. During the regions of the fires the Green ash could be found far out in the prairie occupying the isolated gopher hills, but burned down so as form a sort of woody crown-former.

The Creek Bottom.—Along the smaller creeks there is usually only a narrow belt of forest on both banks, extending from the water up to the flood-plain level. The presence of this forest is due to the moist condition of the creek bank and the layer of alluvium which is deposited at each ordinary rise of the water. The alluvium not only covers the grass and other herbs but gives a very favorable soil for the development of woody seedlings. Where there are sharp bends small, low bars are formed, subject to frequent overflow, and these are covered by a forest of the type in the river valley on a smaller scale. The succession of trees is however not the same. The important tree is the box-elder, which takes the place of the cottonwood along the river. The forest may also extend outward on gopher hills, and the Green ash, so far as it extends up the creek, is the main tree to take possession. The outward extension in the creek bottoms is very marked since prairie fires have ceased. Some low, narrow flood-plains may be entirely wooded, but this is exceptional at present.

The creek-bank forest is continually progressing up stream, and this extension is now very rapid because of the large amount of sediment brought down from plowed ground. On Mulberry creek, near the upper limit of the timber belt, the alluvium was very abundant and covered with a luxuriant growth of large weeds. The beginnings of a forest were shown by the presence of large numbers of young trees of box-elders, cottonwood, and Peach-leaf willow.

The Wooded Bluff.—The steep bluffs along the river, creeks and larger ravines furnish another physiographic form favorable for forest development. The bluffs most completely wooded face the

north. The south-facing bluffs are usually too dry for forest growth. After the slope is of sufficient steepness much wash accumulates toward the base and affords protection for young trees from fire and a good soil for seedlings to develop. Because of shade, slowness of evaporation, and safety from fire, the steep north-sloping bluff often supports a small growth of trees even where the creek bank is barely beginning to harbor isolated thickets and the first young pioneers among the trees. The trees of the wooded bluffs are mostly hackberry, White elm, wild plum, Rough-leaf dogwood, Smooth sumac, and Choke-cherry, with a number of smaller shrubs and lianas.

The Ravine.—The ravine valleys are usually so narrow that fires were very destructive, and formerly they contained little besides small thickets of *Amorpha fruticosa*, usually confined to the banks of ponds, Sand-bar willow, elderberry, Smooth sumac, and Poison ivy, which usually grew as a sort of crown-former with annual aerial shoots. But at present Peach-leaf willows, cottonwoods, and occasionally White elms, Green ashes, box-elders, and escaped Osage oranges and White mulberries are developing very rapidly, so that where fire and grazing are absent little forest belts are appearing where thirty years ago there was nothing but pure prairie. The abundant sediment deposited from the cultivated fields is probably a very important factor at present in facilitating tree development in the ravines. The steep north-facing bluffs of the larger ravines are often covered with thickets of wild plum, Rough-leaf dogwood, Smooth sumac, gooseberry, coral-berry, and raspberry. Very often, also, Poison ivy and Riverside grape are present, and occasionally a tree.

HELIUM IN KANSAS NATURAL GAS.

By H. P. Cady and D. F. McFarland.

SUMMARY.

FORTY-FOUR gases have been analyzed. Three are from other gas-fields than the Kansas field, the remainder from Kansas and the parts of Missouri and the Indian Territory that are really continuations of the Kansas field.

Helium has been found in every gas examined, in quantities ranging from less than a hundredth of one per cent. to nearly two per cent.

The average quantity of helium in the gases from other fields, which included samples from Indiana, West Virginia, and Ohio (0.135 per cent.), was much less than the average for gases from the Kansas field (0.335 per cent.).

Kansas gases exhibit the widest variation in the quantity of helium. The highest amount found was 1.84 per cent., in the gas from Dexter, in Cowley county, while the lowest was from Paola, in Miami county.

An examination of the geographical location of the various sample shows a remarkable regularity in the distribution of the helium.

If the points which show equal quantities of helium be joined together on the map, it will be seen that the lines follow a general direction of northeast to southwest, and that the lines are roughly parallel. By this means it may be seen that on the eastern side of the field the helium content is very small, nearly all being below 0.10 per cent., the single exception being Olathe gas, which shows 0.40 per cent.

Helium content rises as we go west, reaching a maximum along a line connecting Dexter and Eureka. Then the few samples which could be obtained from the extreme western edge of the field, as at present developed, show a sudden falling-off in the amount of helium. At Arkansas City, only about twenty miles from Dexter, the quantity is only 0.16 per cent. There is a rise from here to the western edge of the field of nearly half a per cent., the sample from Elmdale, the furthest west of all, giving 0.56 per cent.

It is further to be noted that the quantity of nitrogen in the gases rises or falls generally with the quantity of helium, although a strict proportionality has not been found; also, in general, the quantity of combustible constituents in the gas varies inversely

with the quantity of helium and of nitrogen. A gas high in helium is low in methane and other combustibles, and high in nitrogen, while the gas low in helium is high in combustibles and low in nitrogen—a much better gas for heat production. The economic significance of these facts cannot be discussed here, but they have a very important bearing upon the use of the gases for domestic and industrial purposes.

If the lines of equal helium content be compared with the lines of outcropping of the various successive geological strata across the eastern part of the state, a marked similarity is at once noted.

The lines follow almost the same course and indicate a connection between geological structure and distribution of the helium. This relationship will be further inquired into as time permits.

Kansas is to be congratulated on the possession of an unlimited and easily available supply of what has been considered a very rare element, a supply which has never been suspected before. It assures the fact that helium is no longer a rare element, but a very common element, existing in goodly quantity for the uses which are yet to be found for it.

A NOTE ON THE DETECTION OF CYANIDES.

By H. P. Cady, University of Kansas, Lawrence.

THE detection of cyanides in the presence of ferrocyanides, ferricyanides or sulfocyanates is complicated by the fact that most of the tests for the cyanides are not direct tests, but involve the formation of ferrocyanides or sulfocyanates from the cyanides, and, consequently, are not applicable in the presence of the above-mentioned substances.

Since hydrocyanic acid is both a very weak and an easily volatile acid, it would seem that one ought to be able to separate the cyanides from admixture with these other substances by making the solution containing them slightly acid and distilling off the hydrocyanic acid. Any of the well-known tests could then be applied to the distillate. There is this difficulty, however, that ferro, and ferricyanides and sulfocyanates will all yield hydrocyanic acid when an acid solution containing them is distilled at the boiling temperature. Hilger and Tamba state that cyanides may be detected in the presence of ferro- and ferricyanides by acidulating with tartaric acid and passing a current of carbon dioxid through the solution, taking care not to warm the solution above sixty degrees. On account of the restricted conditions this method is not adapted to use by students.

The cyanides are salts of very weak acid, while the ferro- and ferricyanides and sulfocyanates are salts of strong acids; as the result of this, the cyanides are, upon going into solution in water, largely hydrolytically split up with the formation of much free hydrocyanic acid, while the hydroferrocyanic acid, etc., are not formed. As a result of this, hydrocyanic acid will distil from a solution of potassium cyanide although the latter is highly alkaline. The hydrolysis of all salts of weak acids is greater if there is present at the same time in the solution the cations of some weak base; hence the hydrocyanic acid will distil much more readily from the potassium cyanide solution if there be added to the latter some ammonium chlorid.

A very simple separation of the cyanogen ion from the interfering ions may be based upon the above. All that is necessary is to make the solution alkaline with ammonium hydroxid, add some ammonium chlorid, and distil at the boiling temperature. Under these conditions the ferro-ferricyanides and the sulfocyanates are

perfectly stable, while the cyanides readily yield hydrocyanic acid, which may be detected in the distillate through the formation of Prussian blue or by the precipitation of silver cyanide in an acid solution of silver nitrate. The simplest method of all, though, is to place a little of the solution to be tested in a small beaker, add ammonium hydroxid and ammonium chlorid; as before, cover with a small watch-glass carrying on the under side a small piece of paper wet with a one-fourth normal solution of copper ammonia sulfate. The beaker is then slightly warmed and set aside for some time. If cyanides are present the paper will lose its blue color, owing to the change of the copper ammonia ion into the colorless cuperous cyanogen ion. By this means as little as one-tenth of a milligram of potassium cyanide may be detected. In order to get the full delicacy of the test the paper must be small and the action must go on for several hours. In the absence of cyanides, but in the presence of the ferrocyanides, etc., the paper will retain its blue color for days.

NOTE ON MERCUROUS SULFATE FOR STANDARD CELLS.

By H. P. Cady, University of Kansas, Lawrence.

CARHART and Hullet have recently recommended that the mercurous sulfate used in the preparation of Clark or cadmium standard cells be prepared electrolytically by using an anode of pure mercury, a cathode of platinium and sulfuric acid as the electrolyte. The mercurous sulfate prepared in this way is crystalline in character and gives very uniform results when made up into cells. It is, however, somewhat troublesome to make and the process is a rather slow one.

A sample of mercurous sulfate, a so-called C. P. article, which gave cells differing from the true value by nearly a millevolt, was rubbed up with a little mercury and kept on a hot plate under dilute sulfuric acid for some hours. At the end of this treatment the sulfate was crystalline and gave cells which agreed almost exactly with those prepared from the electrolytically prepared sulfate. It is easier to buy mercurous sulfate and purify it by the above process than to prepare it by the electrolysis, and the product seems to be as good.

A PROPOSED TEST FOR BLEACHED FLOUR.

By J. T. WILLARD, Kansas State Agricultural College, Manhattan.

WITHIN the last three years there has been a great development of the artificial bleaching or aging of flour. In this it is claimed that the color of the flour is improved and also its baking qualities, so that the treatment gives flour properties that it would naturally acquire on being stored several months. Although boards of health have taken no action concerning this treatment of flour, manufacturers who have not adopted the process and do not wish to go to the expense are claiming that such flour is unwholesome, and the belief that this is the case is not uncommonly held by consumers. A simple test to distinguish artificially bleached flour is therefore something to be desired.

Inasmuch as the bleaching processes in use employ oxids of nitrogen produced in one way or another, it occurred to the writer that Griess's test for nitric acid by means of alphanaphthylamine and sulfanilic acid might be available. In applying this test we have used the modification suggested by Ilosvay, who uses acetic acid instead of mineral acid. One-half gram of sulfanilic acid is dissolved by heat in 150 cubic centimeters of dilute acetic acid. One-tenth gram of alphanaphthylamine is heated with 20 cubic centimeters of strong acetic acid, and the colorless solution poured off from the residue and mixed with 130 cubic centimeters of dilute acetic acid. For use, the two solutions are mixed in equal quantities and two cubic centimeters of the mixed solution added to the liquid to be tested.

In testing flour, about a teaspoonful is shaken with a few cubic centimeters of distilled water and the reagent added directly to it. A pink color of varying intensity is obtained with bleached flour in a few minutes, while unbleached flour gives no reaction. The delicacy of the test is increased by settling out the flour by the use of the centrifuge.

This test, as will be seen, is very speedy. Its applicability, however, is not yet fully determined, as nitrites are subject to oxidation, and possibly other chemical changes might take place with the lapse of time that would cause failure to react for nitrites. The matter is under further investigation touching this point.

ON SOME FERROCYANIDES OF CALCIUM, BARIUM, AND MAGNESIUM.

By F. B. DAINS, Washburn College, Topeka.

WHEN potassium ferrocyanide is added to solutions of calcium, barium and magnesium containing free ammonia or ammonium salts, difficultly soluble precipitates are obtained. Concerning the composition of these precipitates some confusion seems to have arisen. The general idea has been that they were double ferrocyanides of potassium and the alkaline earth metal. Tests, however, showed that the product always contained ammonia; hence it seemed of interest to ascertain whether the precipitate was a definite chemical compound or a mixture of ferrocyanides.

H. Baubigny, in an article on the separation of calcium, barium, and strontium (Chem. News, 72, 27), suggests that after the removal of the barium as barium chromate, and after getting rid of the excess of the chromate, the calcium be precipitated by means of potassium ferrocyanide in ammonium chlorid solution. On the authority of Rose, he calls this precipitate a potassium-calcium ferrocyanide. He also recommends the use of potassium ferrocyanide as a test for calcium.

In the text-book of qualitative analysis by Bailey and Cady (first edition) the precipitation of calcium and magnesium by potassium ferrocyanide in the presence of ammonuium salts is mentioned, and the fact pointed out that they contain ammonia. Recently (Jour. Am. Chem. Soc., 28, 1510) Flanders has suggested the use of potassium ferrocyanide in the presence of ammonium chlorid as a test for calcium, and on the authority of Prescott and Johnson (1903, p. 212) calls the precipitate potassium ferrocyanide.

EXPERIMENTAL.

The product formed by precipitating a calcium salt with potassium ferrocyanide in the presence of a large excess of ammonium chlorid or nitrate was thoroughly washed with hot water, and dried, first on a porous plate, and then at seventy degrees in an oven. Qualitative tests showed that the product contained potassium, ammonium, calcium, the ferrocyanogen ion, and water. Analysis of various preparations gave results which correspond to the folowing formula: $K_2CaFe(CN)_6$, $4(NH_4)CaFe(CN)_62H_2O$.

	Found.	*Calculated.*
NH	9.62	9.49
K	5.10	5.15
Ca	13.18	13.19
Fe	18.48	18.39
H_2O	2.24	2.37

When potassium ferrocyanide is added to a barium salt under similar conditions, a light yellow, heavy, granular precipitate falls, which is soluble enough in hot water so as to admit of crystallization from that solvent. This fact was known to Thenard, since he suggests the separation of barium from strontium by precipitating the barium in ammonia solution by means of potassium chromate. (Children's translation of Thenard's Essey on Chemical Analysis, 1819, p. 123). The analysis of the material, air-dried on a porous plate, gave results corresponding to the formula $K_2BaFe(CN)_6$, $4(NH_4)BaFe(CN)_6 15H_2O$.

	Found.	*Calculated.*
K	3.55	3.49
NH_4	6.76	6.44
Ba	30.46	30.67
Fe	12.53	12.48
H_2O	11.80	12.06

Magnesium salts under these same conditions give a fine white precipitate, difficultly soluble in water and acids. In Watts's Dictionary, edition of 1869, a ferrocyanide of magnesium and ammonium is mentioned as having been obtained, but in an impure state. The cause of this lies in the carrying down of a slight excess of magnesium, probably due to the formation of a small amount of $Mg_2Fe(CN)_6$. The product carefully washed and air-dried to constant weight gave figures which correspond best to this formula: $K_2MgFe(CN)_6$, $5(NH_4)MgFe(CN)_6 10H_2O$.

	Found.	*Calculated.*
Ka	3.85	4.22
NH_4	9.79	9.72
Mg	8.43	7.87
Fe	17.96	18.06
H_2O	9.94	9.70

DETERMINATION AND COMPARISON OF SOUND INTENSITIES.

By Bruce V. Hill, University of Kansas, Lawrence.

WE are now able to compare the power and efficiency of different luminants with considerable ease. For similar measurements dealing with the energy from sounding bodies we have, however, at present no method. Several properties of the vibrations and waves concerned in the two cases, as well as the peculiarities of the sense-organs involved, are responsible for this. To compare the illumination power of two lamps, the common procedure is either to produce equal illumination from the two sources on adjacent parts of the same screen, or so to adjust the two that shadows, of equal depth are cast. Now, both of these methods depend upon the fact that light travels very nearly in straight lines. Sound waves, having so much greater wave length, do not even approximate rectilinear propagation.

The eye is very sensitive to changer of intensity, but not to small shadings of color. With the ear the reverse is true. Very small changes of pitch can be perceived, while variation of loudness is required to make itself noticed. A lamp varying even slowly is unpleasant, while, in music, the accent and shading are necessary, and so by habit we are less able to discriminate slight changes of sound intensity. Again, the ear has a power of analysis which the eye does not possess. A white light may really be made up of a number of different combinations of colors. In the sound from a number of instruments, however, the ear can pick out, not only the separate pieces, but the overtones given by them, amounting in all to hundreds.

All these things make it impossible to compare tone intensities as we do those of light. The effect of a given source of light might be measured by its chemical action, but, so far as we know, there is no corresponding effect due to sound. There are several effects produced by sound, and of these we will speak briefly, and give a short account of the attempts to solve the problems of sound-intensity measurement. The action of the microphone has long been known. If in the circuit with a battery and a telephone receiver is placed a carbon rod, resting loosely upon carbon supports at its ends, a very slight jar varies the resistance of the contacts and causes a sound in the receiver. Three nails in H shape make

a fairly sensitive microphone. The ordinary transmitter is a device on the same principle. A number of years ago Wm. Weber suggested the use of the variable current thus produced as a measure of sound intensity. The currents in the secondary circuit of a local battery telephone set are so exceedingly small, however, that there has until recently been no reliable instrument to measure them, though several have been proposed. Even now it is not certain that the instruments suggested for this purpose will be successful. This method will be touched upon later.

In 1878 and 1881 Vierordt published several papers in which he describes methods of comparing sound intensities by the distances to which they were audible. He found that the law of inverse squares does not hold as in the case of light, but that the intensity decreases as the inverse first power of the distance. Here he depends upon the ear, which is very unreliable, especially at the *threshhold of sensation.* Rayleigh has found that, under certain circumstances, no relation seems to exist between the intensity of the stimulus and that of the resulting sensation. Certainly the ear is much more sensitive to sounds of some pitches than to others. Even if the method of Vierordt were trustworthy it could not well be used, as considerable space must be had out of doors, and quiet.

Next in the point of time came the suggestion of Overbeck. He used a microphone with but two carbon contacts, the one resting lightly on the other and the whole upon a resonance board. He showed that, to a certain degree of approximation, the increase of the resistance of this arrangement, when acted upon by a sound vibration, was proportional to the intensity of the sound falling upon it. It was therefore put into one arm of Wheatstone's bridge, a balance obtained when the microphone was at rest, and the deflection of the galvanometer produced by a sound wave falling upon the apparatus measured. This was useful only for sounds of moderate intensity and for the range of pitch c to c′.

Dvorak describes a number of contrivances depending upon the repulsion of resonators and of light aluminum vanes perforated with holes larger on the one side than on the other. In a similar way Professor Wood, of Baltimore, has made a sound pedometer, the speed of which depends upon the intensity of the tone, but which cannot be used as a measure of it. Lord Rayleigh suggested placing a light mica vane within a tube at an angle of forty-five degrees to the axis of the tube. At the open end of the tube was an elastic diaphragm at the node of a standing wave of the sound to be studied. When the sounding body was in action the vane tended

to set itself along the axis of the tube. This motion was balanced by the action of a magnet upon the vane and held in position by the field of the earth. E. Grimsehl used a similar arrangement.

None of the methods so far described, however, with the exception of that of Weber, is of more than incidental interest. All depend upon assumptions and have very limited possibilities. Prof. Max Wien, in 1889, constructed his *optical telephone.* Upon the diaphragm of a special receiver he placed a small mirror which vibrated with the varying current in the magnet spools, thus giving a measure of the amplitude of the vibration of the diaphragm. Later, he placed the mirror directly upon a membrane actuated by the vibration to be studied, without the intervention of the telephone. If the tone under consideration is *pure*, that is, if it can be represented by a simple sine function, the intensity in absolute measure may be calculated from the amplitude thus found. For complex tones, and those with which we have most to do are very complex, this method is of no direct value.

G. Stern, in 1891, used a special microphone to study the intensity of sound in the various parts of a room. The method is merely qualitative and gives us little of any value.

Mr. B. F. Sharpe, working with Professor Webster, at Clark University, estimated the intensity of sound as follows: One total reflecting mirror of a Michelson refractometer is made small and light and mounted upon a thin plate forming part of the wall of a Helmholtz resonator. The objective of the observing telescope was a lens mounted upon one prong of a tuning-fork of the same period as the tone to be studied. A system of oblique bands was formed, the inclination of which is a function of the intensity of the sound. Here also the method is inapplicable to anything but a pure tone.

As shown mathematically by Rayleigh, radiation must exert a steady pressure upon a surface that opposes its advance. Nichols and Hull demonstrated the existence of this pressure in the case of light several years ago. More recently Altberg constructed an apparatus consisting of a reflecting wall in which there was a circular hole. Within this hole was a plunger supported upon one arm of a torsion balance. In this way he succeeded in measuring the actual energy given out by a glass tube set in longitudinal vibration by the friction of a rapidly rotating rubber of cloth wet with alcohol. With a sound so loud that he was obliged to stop his ears while working with it he found a radiation pressure of 0.25 dynes cm^2. If this method could be applied to sounds of ordinary intensity it would certainly be very valuable, but this noise was prob-

ably hundreds of times more intense than those with which we ordinarily have to do. When working with light the suspended parts could be put within an air-tight vessel and so protected from air currents, but in the case of sound measurements this is impossible, as that would shut off the pressure that we desire to measure. This puts a very definite limit to the delicacy of the suspended system that may be used in such an instrument. Some form of microphone, properly calibrated, will perhaps prove in the end the most satisfactory means of estimating sound intensities.

III.

GEOLOGICAL PAPERS.

"Some Geological Studies on Northwestern Washington and the Adjacent British Territory."

By Albert B. Reagan, Mora, Wash.

"Some Animals Discovered in the Fossil Beds of Kansas."

By Charles H. Sternberg, Lawrence, Kan.

SOME GEOLOGICAL STUDIES ON NORTHWESTERN WASHINGTON AND ADJACENT BRITISH TERRITORY.

By Albert B. Reagan, Mora, Wash.

THE region under consideration extends in a north and south direction from the city of Bellingham north to the Fraser river in British Columbia; and in an east and west direction from the foot-hills of the Sumas and Selkirk mountains to Georgian Bay. For the most part its practically low, level surface consists of estuary and glacial deposits, some trap and granite rock, and a small patch of Eocene exposed in British Columbia and a larger patch of Eocene at Bellingham. The whole region was once heavily timbered, but now, on the southern side of the international boundary-line, it is about half cleared and the other part might be termed "logged off" lands, as the best timber has been cut. And now railways and wagon roads traverse it in all directions. The area in British Columbia is still in the virgin state, with the exceptions of a few clearings here and there. In the Fraser delta, however, there are large areas of cleared land. At places it is thickly settled. Also large cities are on the river here. The cleared lands are valued at from $60 to $120 per acre; the "logged off" lands on the American side, $10 per acre. The region is a difficult one in which to trace out geological formations in detail. Only a reconnoisance trip was made in British territory.

LITERATURE.

In volume I of the Washington Geological Survey, Prof. Henry Landes, state geologist, describes the region in the vicinity of Bellingham, giving the resources of the same in detail. A further mention of his work will be given when the subjects concerned are considered.

STRATIGRAPHICAL SECTIONS.

1. Section at the water's edge one-half mile south of Fish Point:

1. Dark brown sand, containing layers of oyster shells, which seem to indicate that the deposit had evidently been at least a tide-water beach. ..... 1 foot.
2. Light brown sand tinged occasionally with ocher.....10 feet.
3. Blue ground moraine clay, containing small water-worn granite fragments, also large granite boulders of glacial origin, as is demonstrated by parallel scratches and by one face of the boulders being flattened.....14 "

2. Section on Bellingham bay, one and one-half miles south of Fish Point:

1.	Black earth	6 feet.
2.	Yellow clay, containing round fragments	8 "
3.	Sand	10 "
4.	Coarse gravel, cobblestones, and sand—an occasional large boulder—all promiscuously mixed, apparently outwash material at the foot of the glacier. Occasional sorting is shown	20 feet.

3. Section 300 feet south of section 2:

1.	Alluvium	4 feet.
2.	Yellow clay and sand	14 "
3.	Very coarse gravel, containing many cobblestones	10 "
4.	Banded coarse sand	16 "

4. Section 300 feet south of section 3:

1.	Alluvium	4 feet.
2.	Yellow sand	10 "
3.	Gravelly sand	10 "
4.	Laminated coarse sand	14 "
5.	Coarse gravel	4 "
6.	Light brown, massive, very fine sand	3 "

5. Section 300 feet south of section 4:

1.	Alluvium	4 feet.
2.	Yellow sand	14 "
3.	Light brown, fine sand	10 inches.
4.	Coarse, laminated sand, with laminæ dipping south 45 degrees	16 feet.
5.	Coarse, laminated sand	8 inches.
6.	Coarse gravel, bedded, with beds dipping south at an angle of 45 degrees	4 feet.
7.	Not seen	4 "

6. Section 600 feet south of section 5:

1.	Alluvium	4 feet.
2.	Yellow sand	14 "
3.	Massive dark brown sand, containing rounded and angular fragments	28 "

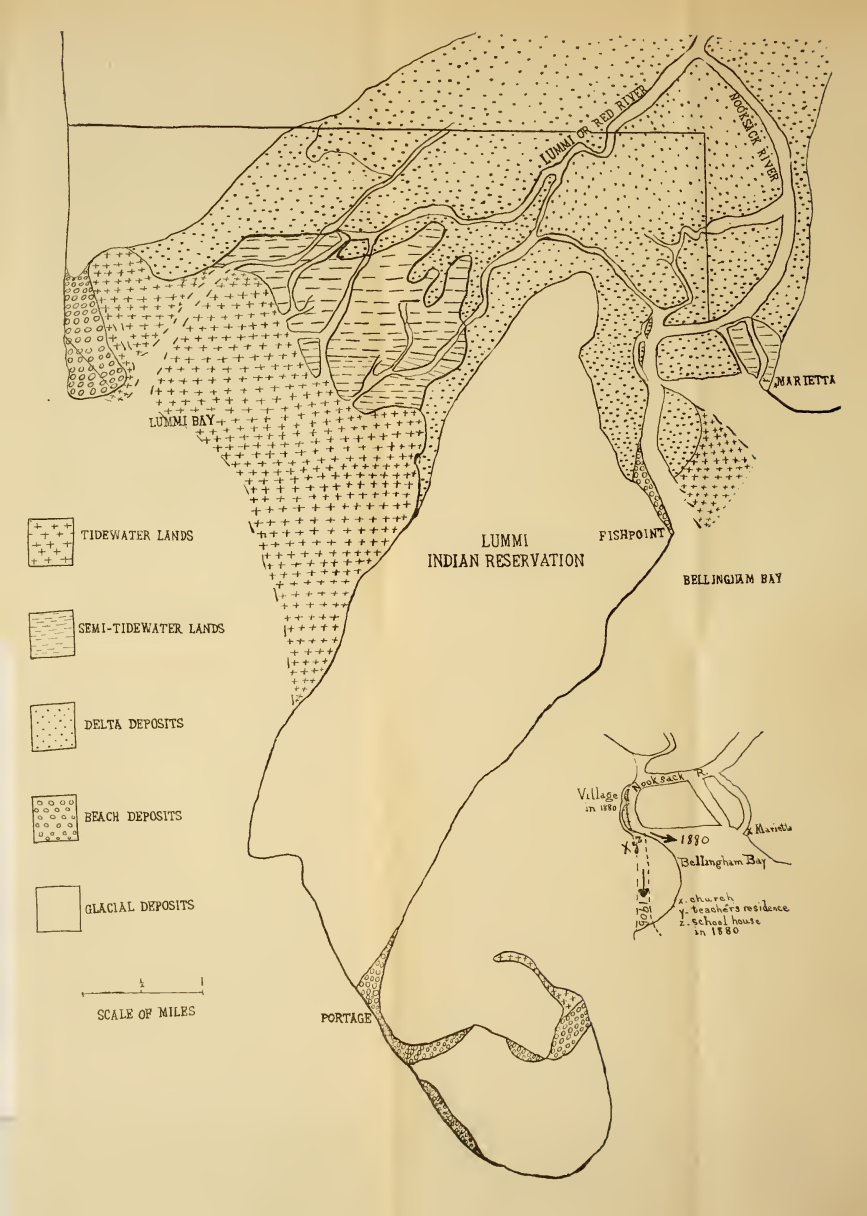
7. Section 300 yards south of section 6:

1.	Sand	10 feet.
2.	Blue clay, containing large boulders. In this stratum there are *Pecten* and other marine shells	30 "

8. Section 600 feet south of section 7:

1.	Yellow sand	20 feet.
2.	Laminated blue clay	2 "
3.	Massive blue clay (*Pecten* shells)	2 "

Sections 2–8 are extraglacial deposits of the narrow moraine


LUMMI OR RED RIVER
NOOKSACK RIVER
MARIETTA
LUMMI BAY
LUMMI
INDIAN RESERVATION
FISHPOINT
BELLINGHAM BAY
TIDEWATER LANDS
SEMI-TIDEWATER LANDS
DELTA DEPOSITS
BEACH DEPOSITS
GLACIAL DEPOSITS
SCALE OF MILES
PORTAGE
Village in 1880
Nooksack R.
Marietta
1880
Bellingham Bay
x. church
y. teachers residence
z. school house in 1880

delta type. They were apparently deposited at the mouth of an osar stream.

In section 5, opposite the mouth of the above glacial stream a glacial foot maintained itself for a considerable time. Later it was pushed further south. That the terminal moraine was at this point is attested by the numerous large boulders in the debris.

9. Section in well at Marietta:

1.	Sand and gravel	10 feet.
2.	Sand containing marine shells	2 "

10. Section 300 yards west of the portage on Hale's Passage:

1.	Soil	1 foot.
2.	Alternating strata of gravel and sand, the strata dipping in the bedding both east and west of the point where the section was taken	16 feet.
3.	Unstratified sand, containing boulders from the size of a pebble to a hundred tons weight	8 "
4.	Very light brown, very finely laminated, promiscuously bedded sand, having a wedge of gravel embedded in it. This sand was seen to pinch out in a short distance both to the east and to the west of the point where the section was taken,	6 inches.
5.	Gravel	2 "
6.	Very light brown sand	1 "
7.	Gravel and light gray, coarse sand, stratified, the striæ being wavy	1 foot.
8.	Laminated, fine, light brown sand, the laminæ very wavy and irregular	1 "
9.	Stratified sand, carrying cobblestones	1 "

11. Section on Bellingham bay, just east of Louis Tsetsatin's house, at the bridge, in section 36 of the Lummi reservation:

1.	Unstratified sand	7 feet.
2.	Blue clay, containing pebbles	6 "

12. Section in well one-fourth mile east of Mountain View:

1.	Clay and sand	14 feet.
2.	Stratum containing sea-shells	2 "

13. Section in Mr. F. C. Reeve's well, two miles east of Birch bay:

1.	Soil	2 feet.
2.	Yellow clay	20 "
3.	Bluish yellow clay	2 "

14. Section in Mr. Chambers's well, one mile east of Birch bay:

1.	White to yellow clay, containing pebbles and boulders	14 feet.
2.	Blue clay, containing sea-shells	6 "

15. Section in well one mile northeast of Birch bay:

1.	Gravelly soil	1 foot.
2.	Gravelly subsoil	2 feet.
3.	Blue clay	20 "
4.	Beach deposits, containing clam-shells	1 foot.

The water in this well is brackish.

16. Section on bluff opposite the railway curve on Semiahmoo bay, near Main street, in Blaine:

1.	Light brown sand, a sand-plain deposit of the Blaine esker	15 feet.
2.	Yellow clay	8 "
3.	Light blue clay	8 "

17. Section in a well opposite the schoolhouse in section 12, township 40, range 1 east:

1.	Clay	14 feet.
2.	Sea-beach gravel, containing boulders and marine clam-shells,	8 "

18. Section in a well in the northeast corner of section 18, township 40, range 1 east:

1.	Mostly quicksand. (The water of the well is brackish and has an iron-rust taste. It is poor boiler water)	10 feet.

19. Section in a well in British Columbia, one-fourth mile north of the northeast corner of section 35, township 40, range 2 east, in the United States:

1.	Clay	55 feet.
2.	Sand and gravel, containing sea-shells	5 "

20. Section in Mr. Waker's well in British Columbia, near the boundary line of section 31, township 40, range 3 east, in the United States:

1.	Clay	45 feet.
2.	Sand (cottonwood brush; sea-shells)	5 "

21. Section on the road six miles west of Abbott's Ford, British Columbia:

1.	Soil	1 foot.
2.	Stream-wash gravel	4 feet.
3.	Blue sand, coarse enough for plastering purposes	3 "
4.	Fine yellow sand	3 inches.
5.	Same as 3	4 "
6.	Same as 4	16 "
7.	Same as 3	6 "
8.	Fine yellow sand	4 "
9.	Blue sand, same as 3	4 "
10.	Minutely laminated fine white sand	4 feet.

22 Section 200 feet east of the last section:

1. Gravel containing boulders ..... 4 feet.
2. Greenish, plaster sand ..... 4 "
3. Fine gravel ..... 2 "

23. Section on the road 100 yards southeast of Abbott's Ford, British Columbia:

1. Brownish red soil ..... 3 feet.
2. Sand containing cobblestones ..... 12 "
3. Cross-bedded coarse sand, containing gravel lenses ..... 4 "
4. Sand and gravel ..... 5 "

24. Section on the road one mile northwest of Sumas lake (Eocene):

1. Not seen ..... 300 feet.
2. Blue shale ..... 10 "
3. Lignite ..... 2 "
4. Dark shale ..... 18 "
5. Lignite ..... 6 inches.
6. Dark blue shale ..... 20 feet.
7. Yellowish, rather massive sandstone ..... 100 "

Parties have tried to mine coal here at several different times; but the seams are too thin and there is too much dirt in the coal to make it pay.

25. Section four miles south of Murphy's Landing, on the Fraser (Eocene):

1. Sandstone, shale, fire-clay, and very small seams of lignite (estimated) ..... 500 feet.

26. Section just west of the railway-tracks at Sumas City:

1. Sand and gravel ..... 42 feet.
2. Sandy gravel ..... 40 "
3. Sand ..... 20 "

27. Section in a well in the southwest quarter of township 40, range 4 east:

1. Light, sandy yellow clay ..... 8 feet.
2. Quicksand ..... 4 "

28. Section on the road two and one-half miles east of Everson:

1. Soil ..... 3 feet.
2. Coarse gravel ..... 10 "
3. Fine gravel ..... 12 "
4. Plastering sand ..... 2 "

29. Section in road cut on the Bellingham northeast diagonal road, one mile south of Lawrence post-office:

1.	Sandy soil	2 feet.
2.	Sand	10 "
3.	Blue to yellow clay	15 "
4.	Blue clay	20 "

30. Section on the Bellingham road two miles southwest of Lawrence post-office:

1.	Soft blue clay	27 feet.

This clay has been tested and is said to be a good potter's clay. It is also said to be a good brick clay. In quantity it is almost inexhaustible.

At the base of this clay, 100 feet from the surface, in East Rome, near Lawrence post-office, gas was struck; but it was not in paying quantities.

FORMATIONS IN DETAIL.

Trap.—A trap-rock dike was found running in an east and west direction from near Abbott's Ford, British Columbia, to Sumas lake. It is composed of schist and serpentine rock, through which a ridge runs carrying gold, from fifty cents to a dollar and a half per ton. The height of the dike ridge is 500 feet (estimated).

Granite.—A patch of granite fills the triangle between the Sumas and Fraser rivers at their confluence. This area, which was examined only in a very general way, was found to contain iron-ore beds, the extent of which is yet undetermined.

Eocene-Miocene (marked Eocene on the map).—This formation is composed of light bluish gray to light buff sandstones and light gray to black carbonaceous shales, grading into seams of more or less impure coal. The measured thickness, according to Mr. Bailey Willis,[1] is 10,000 feet. The formation is much broken. Some earth blocks of it are raised to a high altitude, with the strata still practically horizontal, an example being the greater part of the Eocene area mapped in British Columbia; other earth blocks are pitched at a high angle, sometimes reaching or exceeding even ninety degrees. The formation seems to be of lake origin, the coal-measures of Eocene age; the series above the coal, Miocene. Prof. F. H. Knowlton, of the United States Geological Survey, after correlating the fossils of this formation, places its age as somewhere near the Middle Tertiary.[2] For a more detailed de-

1. Geological Survey of Washington, vol. I. part IV, p. 44.

2. Preliminary Report on Fossil Plants from the State of Washington, collected by Henry Landes, 1901.

scription of this formation, see Eocene Epoch[3] and Geology of the Coal-measures of Washington.[4]

PLIOCENE.—A conglomerate rock was found in a little valley about four miles south of Murphy's Landing, on the Fraser river. A much larger area of the same kind of rock was found on the foot-hills just north of the Sumas mountains. It is undoubtedly much later in age than the Eocene-Miocene of the same region, because in British Columbia it fills a chasm left by the faulting of that formation. As no fossils were found, its age could not be determined. Its horizon, however, would seem to place it in the Pliocene.

GLACIAL.—The glacial deposits, which exceed 500 feet in thickness, are the surface rock of the entire region from the foot-hills to Georgian Bay, except where they are covered with recent deposits. They were deposited in the then Georgian Bay from the Mt. Baker and British Columbia glaciers. At the culmination of glacial times these two glaciers seem to have been one continuous ice-sheet thousands of feet thick which extended south probably to the Olympic mountains and westward to the Pacific;* but, as the epoch began to wane, they became separated and acted independently of each other. The Mt. Baker or Nooksack glacier then seems to have followed about the course of the Nooksack river to Lynden, and would have continued its course in a northwestern direction if it had not encountered the foot of the northern ice-sheet. This turned it in its course from a northwest to a southwest direction, causing a push-medial moraine, now a ridge, to be formed where the two glaciers came in contact, and a dump-terminal moraine from Blaine south to the portage along the Georgian Bay coast. The Fraser glacier at this time was stopped in its southern advance and turned westward by the granite trap and Eocene highlands in British Columbia, and further deflected westward by the Mt. Baker glacier. Its final dump moraine was probably in Georgian Bay, to the west of the present coast-line. On their final retreat from the region these two glaciers left elevated areas where their push-medial, terminal and lateral moraines had been; and estuaries or sounds between these and the foot-hills, all the country but the morainic strips being at or below sea-level. These strips are typically glacial, and present practically all the phenomena peculiar to a glacial region.

3. Landes, Washington Geological Survey, vol. I, part I, p. 29.

4. Loc. cit., part IV, p. 43.

*This glacier passed over Orchis island, which is 1800 feet in height, the glacier stripping the island of practically all its soil.

Subglacial Till.—This is a gray, blue or black clay. It is very hard, and when dry shows a joint structure. In many places it is a gumbo. At places where it is the surface rock it is very poor soil. It is of great thickness, and underlies the entire region to the foot-hills. It was deposited in sea-water, as its marine shells attest.

Fossils from the Subglacial Till.—The fossils figured and described here were taken from the subglacial till one mile below Fish Point, on the Bellingham Beach side of the Lummi Indian reservation.

Leda fossa (Baird). Figures 1*a* and 1*b*.

"Shell small, elongate, convex, thin; umbones anterior, turning[5] slightly toward the posterior end, which is elongated, narrow, and truncated; anterior end short and evenly rounded; sculpture nearly obsolete, a few concentric lines discernible; escutcheon long, narrow, smooth, and deep-set; an elongate process on middle of interior of posterior end; hinge with small internal cartilage pit, and numerous sharp teeth on each side."

Dimensions: Length, 15 mm.; alt., 8.5 mm.; diam., 5 mm.; umbo to posterior end, 10 mm.; to anterior end, 7 mm.

Distinguishable by lack of sculpture.

Living: Puget sound (Carpenter).

Pleistocene: San Pedro, Cal. (Arnold).

Leda hamata (Carpenter). Figures 2*a* and 2*b*.

Shell similar to to *L. fossa*, except its surface is sculptured by strong concentric, raised lines; a raised band, strongly transversely sculptured by continuations of the concentric ridges, passes from the umbo around the escutcheon to the posterior end; escutcheon deep-set, smooth.

Dimensions: Length, 11 mm.; alt., 6 mm.; diam., 4 mm.; umbo to posterior end, 7.5 mm.; to anterior end, 5 mm.

Living: Santa Barbara to Catalina, Cal. (Carpenter).

Pleistocene: San Pedro and San Diego, Cal. (Arnold).

Pliocene: Deadman island, San Pedro, Cal. (Arnold).

Leda tenuisulcata (Stimp.) Figure 3.

Shell small, thin, elongate-triagonal, convex, somewhat inflated; umbones anterior, turning slightly toward the posterior end; shell rounded before, much elongated behind, the posterior length about twice the anterior. It is furnished with very fine, distinct, con-

5. Ralph Arnold's description; California Academy of Science, vol. III, p. 96.

centric striæ. A raised area, transversely sculptured by continuations of the concentric striæ, passes posteriorly on either side of the escutcheon from the umbones to the posterior margin of the shell. Both the anterior and posterior teeth are bent, the angle of each being directed toward the beak. Margin entire; cavity of shell rather deep. On the interior of the posterior end is an elongated, somewhat arrow-head shaped, raised process. The escutcheon is smooth.

Dimensions: Length, 6 mm.; height, 3 mm.; umbo to posterior end, 4 mm.; to anterior end, 2 mm.

Pecten (Chlamys) jordani (ARNOLD). Figure 4*a*.

Arnold's description:[6] "Shell of medium size, shape of *P. hericeus*, inequivalve, rather thin; right valve with twenty-five to thirty angular, smooth-topped, imbricated ribs, which become dichotomous after reaching a length of about 30 mm.; interspaces deeply channeled and narrower than the ribs; anterior ear imperfectly radially ribbed with six ridges, and showing elevated, concentric, incremental lines; posterior ear nearly obsolete, showing four ribs; byssal notch not deep; left valve shows twenty-five to thirty narrow, convex ribs, showing imbrications only slightly; interspaces as large as ribs; after a diameter of about 30 mm. has been reached by the shell, small riblets appear in the widening interspaces; anterior ear shows five narrow imbricated ridges, with wide interspaces; both valves show a tendency to contract suddenly at the basal margin upon nearing a completion of growth; surface of both valves covered with a minute, lattice-like sculpture which is generally worn off on exposed portions of the shell.

"Allied to *P. opuntia* (Dall.), but having fewer ribs on disk and ear, and having dichotomous ribs after reaching a diameter of 35 mm. Distinguished from *P. hericeus* and *P. hastatus* by not having fasciculated nor spinose ribs."

Pleistocene: San Pedro and Santa Barbara, Cal. (Arnold).

Pliocene: San Pedro and Santa Barbara, Deadman island, and Packard's Hill, Cal. (Arnold).

Dimensions: Length, 42 mm.; alt., 48 mm.

Pecten rubidos (HDS.) (?) Figures 5*a*, 5*b*, and 5*c*.

Shell of medium size; right valve with twenty-five to thirty broad, smooth-topped, very prominent imbricated ribs which become dichotomous after reaching a length of 45 mm. and also just before reaching the ventral margin; interspaces deeply channeled

6. Loc. Cit., p. III.

and narrower than the ribs; surface of shell covered with a minute latticework where not worn off, also by conspicuous growth lines near the margin; anterior ear imperfectly ribbed with four to six ridges, and showing elevated, concentric transverse ridges and incremental lines; posterior ear small, showing four ribs and conspicuous incremental lines; left valve not seen.

This shell differs from *P.* (*Chlamys*) *jordani* in that the shell is larger and thicker, that its length and altitude are not the same, and that the ribs of the right valve, the valve seen, do not become dichotomous till they are about 45 mm. in length.

Dimensions: Length, 55 mm.; alt., 55 mm. (measure of 5*b*).

Septifer bifercatus (?). Figure 6.

The specimen given here is a fragment of the left valve. By a careful comparison with identified specimens it was doubtfully classed as above. Beds of these shells were found, but on account of their long interment they all crumbled to dust on exposure to the air. This fragment was saved with the greatest difficulty.

Tapes staminea (CONRAD). Figure 7.

Arnold's description:[7] "Shell of medium size and thickness, suboval, convex; surface sculptured with numerous crowded, rounded, radiating ridges and concentric lines, which are most prominent on the anterior end; no lunule; margin sometimes crenulated; hinge narrow; ligament narrow, long; three teeth in each valve; posterior two in right valve and middle one in left valve bifed; pallial sinus long, rounded; muscle impressions not sunken.

"This is a variable species; the shape of the shell and the sculpture varying in different individuals . . . "

Dimensions: Length, 20 mm.; alt., 14 mm.

Living: Straits of Fuca to Lower California (Cooper).

Pleistocene: Santa Barbara to San Diego, Cal. (Cooper); San Pedro, San Diego, Cal. (Arnold).

Pliocene: Santa Rosa; Twelve Mile House, San Mateo county, Kirker's Pass, Contra Costa county, Monterey and San Fernando, Cal. (Cooper); San Diego, Cal. (Arnold).

Miocene: West of San Jose; Foxin's, Santa Barbara county, California (Cooper).

7. Loc. cit., p. 150.

Cardium nuttallii (MART.) Figures 8*a* and 8*b*.

Shell medium size, cordate, inflated, equivalve; each valve with twenty-five to thirty angular imbricated ribs which seem to have been continuous from beak to dorsal margin (the surface of the shells obtained are much worn); interspaces wider than the ribs; surface marked with numerous transverse lines of growth; beaks prominent; abductor scars subequal, pallial line entire.

Dimensions: Length, 36 mm.; alt., 36 mm.

Living: Puget sound; Georgian Bay.

(?) **Abra** (?). Figure 9*a*.

The teeth, pallial line and muscular impressions having been removed from this shell, has made it impossible to identify it definitely.

Macoma nasuta (CONRAD). Figures 10*a* and 10*b*.

Arnold's description:[8] "Shell of medium size, ovate compressed, thin; anterior side dilated; posterior side cuneiform, extremity much above line of base; posterior dorsal margin straight to angle where it joins line of truncation; fold carinated on right valve; umbone slightly anterior to center, slightly prominent, narrow cardinal teeth in each valve; no laterals, ligament external, long, straight, narrow; pallial sinus large, expanding interiorly, that of left valve joining anterior muscle impression at its lower posterior angle.

"Distinguishable from *M. secta* by smaller size, less convex valves, less altitude, longer straight posterior margin, and larger, less prominent ligamental callus; from *M. inquinata* by larger, longer shell, less convex valves, less relative altitude, straight dorsal margin with truncation posteriorly, and by less central umbones; from *M. yaldiformis* by more cuneiform posterior extremity, long, straight, posterior dorsal margin, and by having beaks anterior to center rather than posterior; from *M. indentata* by beaks being more anterior, being broader, and by lacking the prominent folds, indentation of ventral margin, and prominent projection of posterior extremity; from *M. kelseyi*, which closely resembles it, by broader shell and by more oblique truncation of posterior extremity. . . ."

Dimensions: Length, 30 mm.; alt., 22 mm.

Living: Alaska to San Diego; Kamtschatka (Cooper).

Pleistocene: Santa Barbara to San Diego (Cooper); San Pedro; San Diego; Ventura (Arnold); Lummi; Blaine.

8. Loc. cit., p. 163.

Pliocene: Eagle Prairie and Danger creek, Humboldt county, California; Santa Rosa; San Fernando (Cooper); San Diego (Arnold).

Miocene: Sunol, Alameda county; Foxin's, Santa Barbara county, California (Cooper).

Macoma indentata (CARPENTER) (?). Figure 11.

Arnold's description (in part).[9] Shell rather narrow, suboval, compressed, thin; umbones slightly posterior to center; anterior end long and evenly rounded; posterior dorsal line straight; posterior extremity much projected and sharply rounded; fold prominent.

Dimensions: Length, 14 mm.; alt., 10.5 mm.; umbo to posterior extremity, 8.5 mm.; to anterior extremity, 10 mm.

This shell is like *M. indentata* described by Arnold, except it is much smaller.

Macoma inquinata (DESHAYES). Figure 12.

The only specimen obtained is the broken left valve represented in the figure.

Shell convex, thin; umbones subcentral; anterior end dilated; posterior end evenly arcuate from umbo and acutely rounded at posterior end.

Dimensions: Length, 11.5 mm.; alt., 8 mm.; umbo to anterior extremity, 7 mm.; to posterior extremity, 7 mm.

This shell is also much smaller than *M. inquinata* described by Arnold.[10]

Macoma concentrica (BURG.) Figure 13.

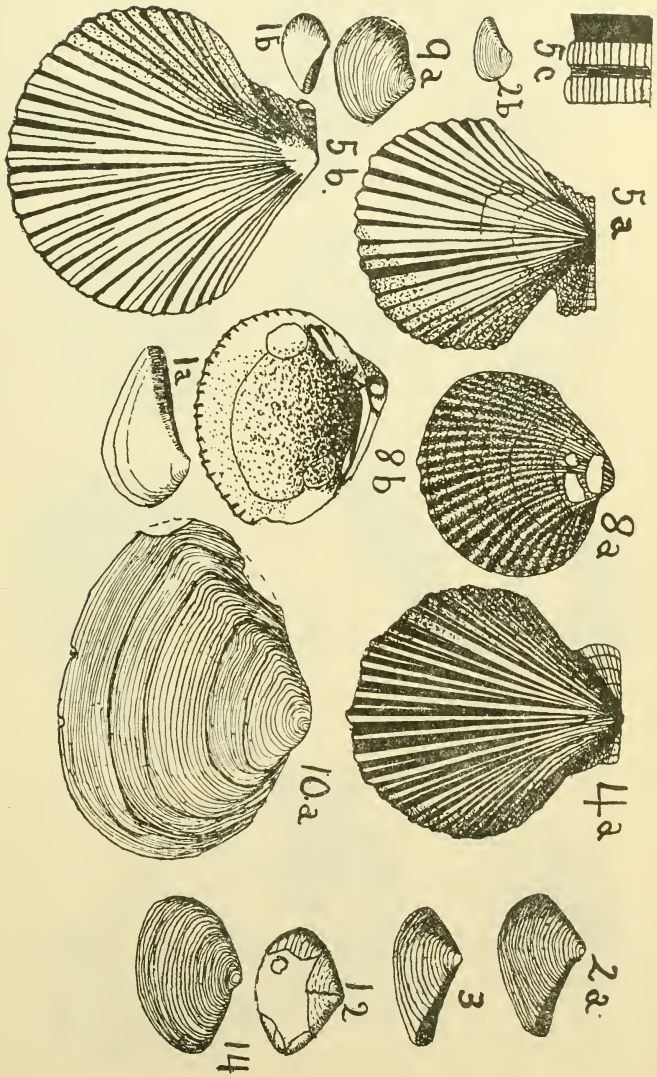
Though much broken, this shell was easily identified by comparing it with specimens in the university museum at Seattle. It resembles *M. nasuta* very much, except that its umbones are slightly posterior and the fold on right valve is less prominent.

Dimensions: Length, 33 mm.; alt., 22 mm.; thickness of right valve, 2.5 mm.; umbones to anterior extremity, 18 mm.; to posterior extremity, 15 mm.

Living: In Florida.

9. Loc. cit., p. 161.

10. Loc. cit., p. 162.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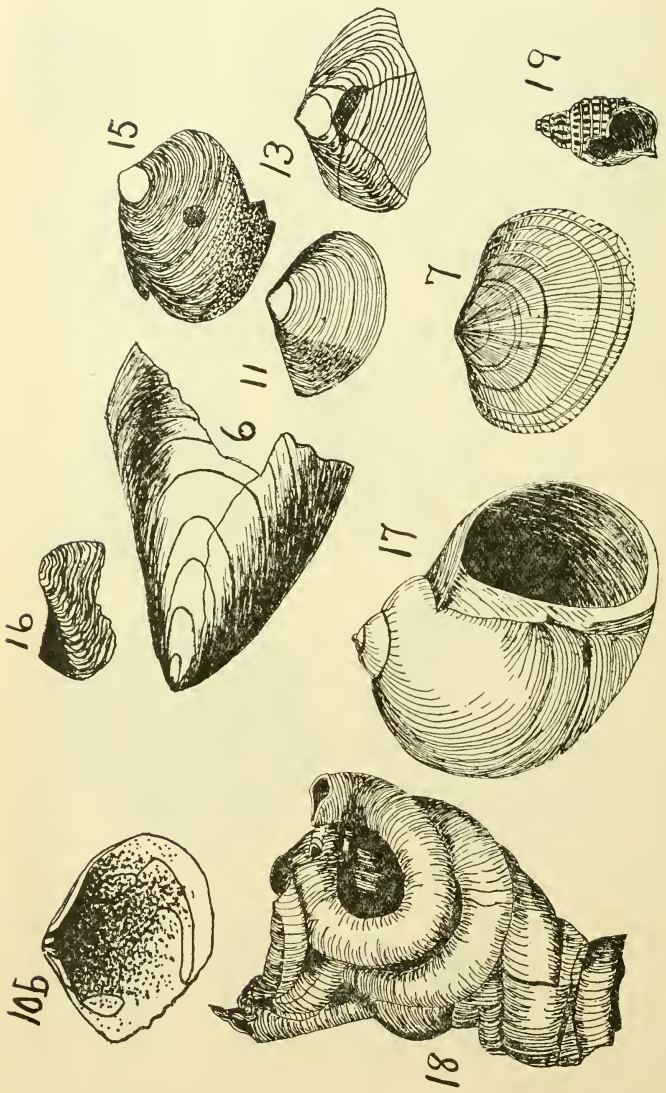
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16
17
10b
18

EXPLANATION OF PLATES.

Leda fossa (Baird).
1*a*. Right valve, 1–1.
1*b*. Left valve, 1–2.

Leda hamata (Carpenter).
2*a*. Left valve, 1–1.
2*b*. Right valve, 1–2.

Leda tenuisulcata (Stimp.)
3. Left valve, 1–1.

Pecten (Chlamys) jordani (Arnold).
4*a*. Left valve, 1–2.

Pecten rubidos (Hds.) (?).
5*a*. Left valve, 1–2.
5*b*. Right valve of old specimen, 1–2.
5*c*. An enlarged double rib of 5*b*, showing lines of growth, magnified.

Septifer bifercatus (?).
6. Part of left valve, 1–1.

Tapes staminea (Conrad).
7. Left valve, 1–1.

Cardium nuttallii (Mart.)
8*a*. Right valve, 1–2.
8*b*. Inside of right valve, 1–2.

(?) Abra (?).
9*a*. Left valve, 1–1.

Macoma nasuta (Conrad).
10*a*. Right valve, 1–1.
10*b*. Inside of left valve, 1–2.

Macoma indentata (Carpenter) (?).
11. Right valve, 1–1.

Macoma inquinata (Deshayes).
12. A much broken left valve, 1–1.

Macoma concentrica (Burg.)
13. Broken right valve, 1–2.

Macoma tampaensis (Conrad) (?).
14. Left valve, 1–1.

Macoma yaldiformis (?).
15. Broken left valve, 1–1.

Saxicava rugosa (Linn.)
16. Right valve, 1–1.

Natica (Cryptonatica) clausa (Broderip and Sowerby).
17. Drawing showing aperture, 1–1.

Vermetes species.
18. Drawing, 1–1.

Ocinebra interfossa (Cpr.)
19. Drawing showing aperture, 1–1.

Macoma tampaensis (CONRAD) (?). Figure 14.

Shell ovate, rather inflated, thin; umbones subcentral to slightly posterior to center; anterior end slightly rounder than posterior; no fold shown; ligamental area short, scooped out.

Dimensisions: Length, 13 mm.; diameter, 8 mm.; umbones to anterior extremity, 7.5 mm.; to posterior extremity, 6.5 mm.

Living: Gordon's Pass, Fla.

Macoma yaldiformis (?). Figure 15.

Shell ovate to elongate ovate, compressed, thin; anterior end dilated; posterior end slightly cuneiform, extremity somewhat truncated; posterior dorsal margin short, straight; fold carinated on right valve; umbones posterior; two (?) cardinal teeth in right valve (left valve not seen); ligament external, short, straight; pallial sinus large, wavy, expanding inside.

Dimensions: Length, 18 mm.; diam., 12 mm.; umbones to posterior end, 8 mm.; to anterior end, 11.5 mm.

Saxicava rugosa (LINN.) Figure 16.

Shell very variable in outline, generally angular oblong-ovate, convex, thick; surface ornamented with conspicuous concentric lines which give the surface a rugose appearance, these being more prominent along the angles of the shell; hinge area prominent; one prominent, well-forward tooth in the right valve (left valve not seen).

Dimensions: Length, 11 mm.; alt., 6 mm.; umbones to anterior extremity, 9 mm.; to posterior extremity, 3.5 mm.

Living: Port Orchard, Wash. (Kincaid).

Natica (Cryptonatica) clausa (BRODERIP AND SOWERBY). Figure 17.

Arnold's description:[11] "Shell of medium size, ovate-globular; spire only slightly elevated; whorls four, evenly convex, though sometimes slightly shouldered; surface smooth, except for fine incremental lines; suture impressed, distinct; aperture semilunar; outer lip sharp; inner lip callous and reflected completely over the umbilicus.

Living: Arctic ocean; Alaska; north Atlantic (Cooper).

Pleistocene: Santa Barbara to San Diego (Cooper); San Pedro; Santa Barbara (Arnold).

Pliocene: San Pedro, Santa Barbara (Arnold).

Dimensions: Alt., 27 mm.; lat., 26.5 mm.; aperture, 19.5x12 mm.

11. Loc. cit., p. 313.

Ocinebra interfossa (CPR.) Figure 19.

Shell fusiform; spire elevated; whorls five in number, each ornamented by five (and a trace of the sixth) rough, subangular, spiral lines which are very prominent on the anterior-posterior portion of the shell; also by cross-lines in the posterior portion and by incremental lines near suture; suture deeply appressed, distinct; aperture subelliptical; outer lip thickened; canal shallow, produced by an angulation of the lip.

Dimensions: Alt., 10 mm.; lat., 6 mm.; aperture, 5.5x4.5 mm.

Vermetes species. Figure 18.

Specimens of this species are abundant in this clay. They usually crumble, however, on exposure to the air.

ENGLACIAL AND SUBGLACIAL TILL.—This till covers practically the whole area, even the estuary regions, it being worked over wholly or in part in these regions by sea action. Its composition is principally sands and gravels to which a great number of boulders are added in the morainic regions. The formations of this till, the most conspicuous of which are marked on the map, are lateral moraines, dump-terminal moraines, push-medial moraines, kames, and kettle-holes, drumlins, ridge-eskers, overwash-marine delta deposits, etc.

LATERAL MORAINES.—A ridge apparently of this type was observed southeast of the northeast diagonal road leading into Bellingham. It was not examined, but its position would seem to indicate that it was such a moraine.

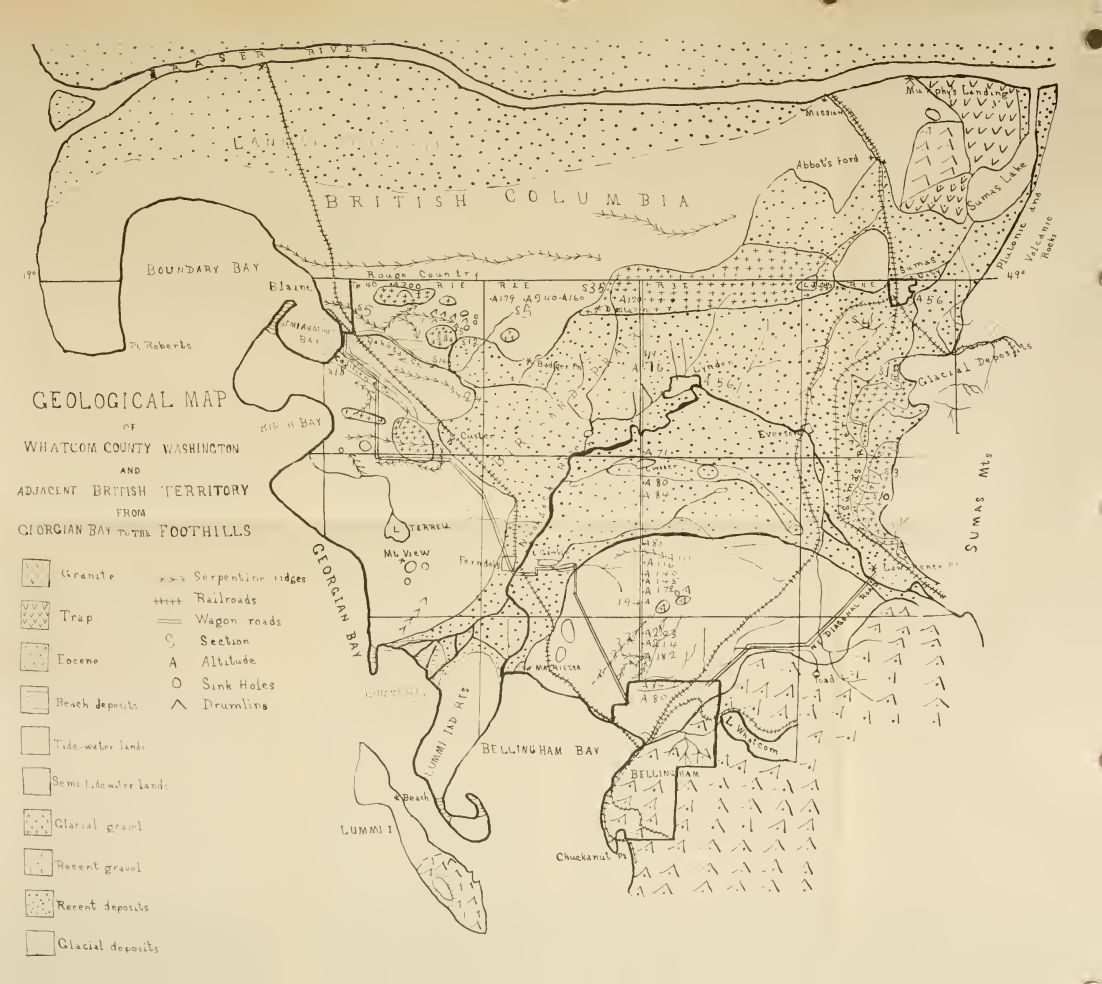
DUMP-TERMINAL MORAINES.—A moraine of this type extended from Blaine south along Georgian Bay to the portage, the Lummi peninsula being the southern end of this moraine. Here boulders do not appear in great numbers on the surface, for reasons which will appear later; but at all places where the sea is making inroads into the land along the bay, the beach is strewn with granite and other plutonic "niggerheads." The foot of the glacier was sometimes further out to sea than the present morainic line; at other times further in on the estuary side. The different dumping-places left sink-holes between them, which are now kettles or lakes; Lake Terrel is an example.

PUSH-MEDIAL MORAINES.—A morainic strip of this type, as we have seen, extends from near Sumas City and Abbott's Ford, in Canada West, to Boundary bay and Point Roberts. It was the middle ground between the two glaciers just before their final retreat. It

is quite wide in places and constitutes the highest glacial deposits in the region. One hundred feet from the surface it was found to contain a large number of boulders and cobblestones, the remainder of its make-up being mostly gravel. Judging from the deposits, the glacier seems to have moved back and forth across this area several times, and near the close of the epoch it seems to have covered it entirely. At this time it seems to have formed a trough area between the two glaciers, and was consequently the dumping-ground. In it, both in the United States and Canada, esker rivers flowed to the sea; the largest south of the international boundary-line entered the bay at Blaine.

Ridge-eskers.—Several ridges, most all of the serpentine type, are to be found in the region about Blaine and Custer and in the region just north of Bellingham. The long broken ridge in Canada seems to be an esker, but the country is too wooded to make a sufficient investigation to determine that it is. At all places where it was examined it was found to be composed of sand and gravel at its summit. An esker several miles long, standing up above the surrounding country like a railroad grade, has its sand plain in the suburbs of Blaine. Where it ends abruptly at the edge of the old Nooksack estuary it is forty-five feet higher than the land on which it is situated. Its course is serpentine, in a western direction. At a place or two it gives off ridges; at others ridges join it. It is composed mostly of gravel at its eastern terminus; but, as Blaine is neared, partly stratified sand becomes the predominant material. It was evidently deposited in a large superglacial stream—a stream that followed the normal course of the Nooksack river and reached the sea by the shortest route. Ridges of esker type cross the Parallel road several places between Bellingham and Lynden. Similar ridges were also seen at Custer and Mountain View.

Kames and Kettle-holes.—In the push-medial morainic area east of Blaine in the inter-esker spaces the country is very knolly and contains many kettles. Most of the hills (marked drumlins on the map) seem to have been formed by the unequal melting of the ice at the glacial margin at the final retreat of the ice-sheet, the superimposed boulders and larger masses of till partially protecting the ice beneath them from melting. The unprotected portions of the ice would melt soonest, forming depressions. Into these the superimposed till on the protected areas would finally be dumped by lateral sliding; and, when the ice finally disappeared, would remain as kames (called drumlins by some writers). The portions of the ice that melted slowest would now represent kettle-


GEOLOGICAL MAP
OF
WHATCOM COUNTY WASHINGTON
AND
ADJACENT BRITISH TERRITORY
FROM
GEORGIAN BAY TO THE FOOTHILLS
Granite
Trap
Eocene
Beach deposits
Tide-water lands
Semi tidewater lands
Glacial gravel
Recent gravel
Recent deposits
Glacial deposits
Serpentine ridges
Railroads
Wagon roads
Section
Altitude
Sink Holes
Drumlins
BRITISH COLUMBIA
BOUNDARY BAY
Blaine
Pt Roberts
Rough Country
Abbot's Ford
Mission
Murphy's Landing
Sumas Lake
Plutonic and Volcanic Rocks
Glacial Deposits
Sumas Mts
Lindeman
Everson
Custer
Ferndale
Mt View
L Terrell
GEORGIAN BAY
LUMMI IAD RES
BELLINGHAM BAY
BELLINGHAM
L Whatcom
Chuckanut Pt
Beach
LUMMI I
Road
Lawrence Pt
Diagonal Road
Wooldale Road
Badger Pt
Sumas River
Lynden
Sumas
19°
49°

holes. These kame-hills and kettles also seem to be intimately connected in origin with the ice edge and to be due to marginal conditions, such as the incorporation of ice fragments in the till, the grounding of blocks of ice, the movement of the ice edge, and the development of underground ice-sheets. Similar kames and kettles were also found in other parts of the glaciated region. Several kettles were noticed at Mountain View.

Drumlins.—There are several boat-shaped knolls and ridges east and north of Bellingham in the lee of the now existing Eocene-capped hills, or of some projecting hard substance now beneath the surface which resisted the wear and erosion of the ice. These hills seem to have collected in a way similar to the way snow drifts behind a wind obstruction, except that they were closed in at the top and on the sides by ice.

Sand-plains.—There are several sand-plains in the region, but the only one specially noticed is that at Blaine, previously mentioned.

Overwash and Glacial Marine Delta Deposits.—These are given together here because the first merges into the second. The whole area south of Blaine, except the estuary part, is covered with overwash material which was deposited at or just below sea-level, as is attested by the marine fossils. It is composed mostly of sand, and ranges from a few inches to several feet in thickness. On the Lummi peninsula, south of Fish Point, it was found to have been dumped into the sea beyond the terminal moraine. There it accumulated to a great thickness.

Recent Deposits.—These are: Tide-water, semitide-water, beach, delta, estuary, lake and swamp deposits.

Tide-water Deposits.—These cover the area between high and low tide-water marks both at the heads of Bellingham and Lummi bays. They are composed mostly of sand. They are valued principally for the setting of salmon nets and fish-traps, and for their clam-beds.

Semitide-water Lands.—These lands are situated at the mouth of the Lummi river, and in the vicinity and to the northwest of Marietta. They are flats over which high tides sometimes flood. They are composed of marine sand and silt. They are seepy, sour areas, which are mostly worthless.

Beach Deposits.—These form the spits of the region, also the narrow neck of land at the portage, and a narrow strip along the coast in the vicinity of the government day-school building.

They are composed mostly of gravel and cobblestones. The spit at Blaine is used as a site for fish canneries. The other spits are used as camping-places in the fishing season.

Delta Deposits.—These cover large areas both at the mouth of the Fraser and the Nooksack-Lummi rivers. The Nooksack delta is quite thick. Logs in it have been found thirty feet beneath the surface. This delta, where it is not swampy, contains some of the best farms of the region. There are also some fine farming sections in the Fraser delta.

Estuary Deposits.—These are found in the valleys of the Fraser and Nooksack rivers, above the respective deltas. As has been stated, these regions were at or below sea-level at the close of glacial times. While thus depressed a coarse, ash-gray sand was spread over the Nooksack estuary from a few inches to many feet in thickness. The thickest deposit of this sand is on the west or slack-water shore of the estuary (the glacial sands are finer and are all brown to light yellow in color). While this sand was being deposited in the slack-water region away from the mouth of the Nooksack river, that river was depositing gravel on the current side. Besides that the waves of the estuary were forming beach gravel by their pounding against the walls of the Sumas mountains on the east and by their tearing down and leaching out the finer material of the glacial deposits of the push-medial moraine to the northwest, the coarser material being left behind as gravel and cobblestones. That these deposits were laid down in sea-water is attested by the fact that they all contain marine shells. Sea-shells were found in them seventy feet above present sea-level. The sites of these estuaries are now occupied, in part, by low prairies; the Bertrand prairie is situated in the Nooksack estuary, the Langly prairie in the Fraser.

Lake Deposits.—Deposits of this type are often very thick. They are composed mostly of sand, silt, and peat.

Swamp Deposits: These cover a great part of the delta and estuary areas and are also found bordering the glacial lakes. The swamps of to-day, however, cover a much less area. The deposits are composed mostly of black muck and peat. When tiled the swamp regions make fine farming lands.

LAKES.

The lakes, besides Lake Whatcom (of which no examination was made), are Wiser, Gamble, Terrell, Judson, and Sumas.

Wiser lake is the lower end of a low area which seems to be an abandoned channel of the Nooksack river; its upper end is now a swamp. The whole area empties its surplus water into the Nooksack through a small stream which connects with the lake. The lake is from thirty to fifty feet deep. It was once much larger than at present. It is now surrounded by a marsh. In this the peat deposit is very thick; at places it is over twenty feet. The peat west of the lake covers over 400 acres. This is being ditched and will soon be farmed.

Gamble lake seems to be a closed slough of the Nooksack—an abandoned channel from which a small stream flows to the river.

Lake Terrell was caused by the terminal moraine making a second halt in its retreat here; the space between the two dumping-grounds is now occupied by the lake. This lake, which is now very shallow, has had about three times its present dimensions. The prevailing wind which has blown over it has been from the northeast; this has caused the waves to etch away the bluffs on its west and southwest sides. This chopping process finally cut an outlet. In the etching-out process the finer material was carried back into the lake and has been no small factor in filling it up. The coarser sand and boulders were left behind on the lake front as a characteristic lake deposit. On account of the filling up of the lake and the lowering of its level by its having cut an outlet, much of the area mapped is a swamp. In this, peat has deposited to a depth of three feet. This swamp region is now being reclaimed by ditching and tiling.

Some years ago a man attempted to drain this lake in order to take its site as a homestead. He was promptly stopped, however.

Judson lake, situated in the Nooksack valley, was caused by a beach bench of the Nooksack estuary damming its natural outlet. Its surplus water now flows north by way of Abbott's Ford to the Fraser.

Sumas lake is the remains of the Nooksack-Fraser estuary (or sound). It is now the back-water region of the latter stream; its area varies with the rise and fall of that river. It often extends as far south as Sumas City. It is very shallow except in its central part. At the time visited a company was being formed to dike it at the south. This, it was claimed, would reclaim 100,000 acres, all of which would evidently make good farm land, as its surface is composed of a stratum of peat from six inches to a foot in thickness.

STREAMS.

The principal streams of the region are the Fraser and Nooksack rivers, and the Dakota, California and Terrell creeks, and their tributaries.

The California and Dakota creeks are both flat-bottomed, wide-mouthed, mud-flat streams that are practically dry when the tide is out. They both have their source on the low divide between the Bay of Georgia and the Nooksack valley at this point. In fact, they have cut their channels back till they rise in the Nooksack valley. At one time they seem to have been channels leading out from the Nooksack estuary. They both pour their muddy waters into Semiahmoo bay.

The creek that drains Lake Judson flows out of the Nooksack valley proper, through a gorge in the glacial deposits, to the Fraser, at Mission.

The Fraser river descends from the mountains and crosses the Sumas valley and then passes through granite walls to the flats beyond, through which it flows to Georgian Bay. It is a large river, of rapid current, and is navigable to the foot-hills.

The Nooksack, a much smaller stream than the Fraser, flows from the foot-hills in a northwest direction to Lynden. At this point it turns abruptly southwestward, which direction it keeps till it reaches the point where it forms its delta. Here it divides and subdivides. The main branch empties into Bellingham bay; the minor branch into the Bay of Lummi, on the opposite side of the Lummi peninsula. On leaving the mountains it has a very rapid current, but below Lynden the stream is so near base-level that its rate of flow is much reduced. In its lower course its channels are very changeable. A change in the main channel in the '80's washed away most of the Indian village of Lummi and compelled the government to move its school buildings to save them; the site of the schoolhouse then is now in the center of the main channel of the river. A jam in the river some years ago flooded the whole country and did great damage to property. Had it not been removed by the government it would have ruined all the delta farm lands and in the end would have changed the main channel of the river to the Lummi bay side of the peninsula. This would have ruined the fishing industry of the Indians and of the white people at Marietta. The river is navigable for small boats to Lynden.

DID THE FRASER RIVER EVER FLOW THROUGH THE NOOKSACK VALLEY?

As has been previously stated, a large estuary or sound once extended up the Nooksack valley from Bellingham bay to the Sumas mountains. An arm of this sound was found to have extended north through the Sumas valley to the Fraser river, both streams then emptying into the same arm of Georgian Bay. The Fraser estuary or sound also then existed; the gap in granite barrier to the Fraser's western outlet was then probably partly cut. Probably this estuary and the Nooksack sound were one continuous sheet of water; the land west of it islands. As the country was gradually elevated above the sea the continuous sound became a swamp area and then dry land. At first the Frazer sent at least a large part of its water through the Nooksack valley to Bellingham bay; the Nooksack was then a tributary of the Fraser. The part of the Fraser, if any, flowing westward, made its way over a fall where it crosses the granite ledge that closes in the Sumas valley. As the elevation was continued, and the barrier to the western outlet of the Fraser was more and more reduced, a greater volume of that river found its way westward. Finally, as it was the larger stream and consequently could erode faster than the Nooksack, it reduced its channel to the same level at the Sumas pass as the Nooksack was at Lynden. This caused a slackened-water, or laken, region to exist between the two streams. As the Fraser crossed the narrowest part of this lake it soon filled that part of it with sediment, only a small stream connecting the lake with it, and all of the water of river found its way westward. On the other hand, the Nooksack entered the broad, shallow end of the lake, or sound. if it still continued to be a part of the ocean, on leaving the foot-hills, and there deposited its sediment in the form of a semicircular ring ten to twelve feet in height completely through the lake. The tide, coming up the outlet of the lake, or up the sound, if the Nooksack valley still remained a sound, probably aided in forming this ridge. The lowering of the stream below the lake lowered the surface of the lake, and left the ridge dry land, with the Nooksack to the south of it. This ridge is to-day the watershed between the two streams. The facts that lead up to this conclusion are these: (*a*) Throughout the level area from Lynden to Sumas lake all the wells are drive-wells, ranging from fifteen to forty feet in depth. The strata through which they are driven are sand and gravel of the river type, the depth of which is unknown. (*b*) The Sumas river, which flows almost parallel with the Nooksack river for several miles, is at the

same level as that river, and is separated from it in many places only by the low ridge previously mentioned. At Everson the Nooksack runs on one side of the depot, and the drainage of the other side is through the Sumas to the Fraser. In fact, it would not take 100 men one day with team and scraper to so change the channel of the Nooksack, at any one of several places, during high-water times, that a great part of its water would ultimately reach Georgian Bay through the Fraser. And the same is true of the latter stream during flood periods. It would back its water up through the Sumas into the Nooksack. In 1894 it flooded the Sumas prairie so that boatmen rowed to the suburbs of Sumas City in the slack water. When visited in June last it was backing water over the prairie within two miles of that city, and the Sumas river was at a stand-still at Everson There seems to be every reason to believe that should these two streams—Nooksack and Fraser—get on a "rampage" at the same time they would flood the entire flat country between them.

DID THE NOOKSACK RIVER EVER FLOW THROUGH THE SUMAS VALLEY TO THE FRASER?

To this question a negative answer can assuredly be given. Had it ever flowed there it would still do so, because, with the low divide removed, as it would then have been, the fall is decidedly northward.

POSSIBLE CAPTURE OF THE NOOKSACK RIVER BY THE FRASER.

The Fraser, on account of its volume and fall in its upper part, is eroding its channel faster than the Nooksack, and has already captured several streams in the valley of the latter. As we have seen, Lake Judson, just north of the low dividing ridge, drains into it, as does also the Sumas river, a river which rises in the very gorge through which the Nooksack descends from the mountains, and which flows almost parallel with it and at about the same level for miles. Furthermore, a very high flood, now that the timber is mostly removed, may at any time cause the Nooksack river to cut through the low divide and turn the greater part of its water into the Fraser through the Sumas river and lake. Such a catastrophe is expected by the settlers at every flood period.[12]

12. The removal of a few feet of the divide west of Lynden would turn a portion of the Nooksack river into Semiahmoo bay through the Dakota creek.

CANALS.

If the people of this region were a water-going people, like the Hollanders, they would have canals running over the country in every direction. A canal connecting the Nooksack and Fraser rivers through the Sumas river and lake route could be easily constructed, large enough to accommodate large gasoline boats; and by the use of locks still larger vessels could be used. Another canal could be almost as easily cut from the bend in the Nooksack river west of Lynden to Blaine through the Dakota creek.

WATER POWER.

No attempt was made at an investigation of this subject. It is very evident, however, that both the Nooksack river and the stream that drains Lake Whatcom—a stream about forty feet wide and having a fall of 318 feet in about three miles, would furnish a great amount of water power. The writer was told that the Bellingham Bay & Eastern railway has a power plant of 10,000 horse-power near Nooksack falls, about fifty-two miles by rail from the city of Bellingham; also that mills were operating on Whatcom creek, in the suburbs of Bellingham. For a complete discussion of this subject, see Professor Landes's report.[13]

WATER.

The water of the Nooksack river and of Lake Whatcom is good drinking water, and also good water for use in boilers. The water in the swampy regions is dark, similar to the color that water has in a barn-yard drain. It is very unwholesome. The water in all the wells near the seashore or in low areas, except in the Nooksack-Sumas prairie region, is brackish, and unfit for use. All the wells in the Sumas valley that have their source in the underlying quicksand and gravel are soft and potable, and most always good water for use in boilers. The water at several places in the Bertrand prairie was found to contain considerable iron and was "hard on boilers," to use the common phrase. All the spring-water examined was pleasant to the taste.

SPRINGS.

The springs are found along the foot-hills and at the heads of the streams having their sources in this region; also in the Mountain View country and in and at the edge of the highland east of Blaine. All the springs are small and none possess medicinal properties.

13. Loc. cit., part V, pp. 32, 33.

WELLS.

The drinking water of all the region back from the main streams is furnished by comparatively shallow wells. The wells in the Sumas valley and in the vicinity of Lynden and Everson are drive-wells, as previously stated, the water being found in gravel and sand. The wells in the vicinity of Mountain View are dug in subglacial till that is so hard that it has to be blasted. This clay is non-porous and the wells dug in it are mere cisterns, the eaves of the houses or barns usually furnishing the water.

MINERALS.

SAND.—Glacial sand covers all the highlands from Blaine to the portage. It is a light brown, usually very fine sand. Some of it is good for plastering purposes, but most of it is too fine. A great deal of it would make good molding sand, and would also be good in city paving and in macadamizing roads. The soil of the region over which this sand is spread is very poor.

The ash-gray sand of the delta formation is coarse, and is, consequently, good plastering sand. Large areas of it are found between Custer and Ferndale. It is of great depth in these localities, and, as the railway crosses them, it could be easily shipped.

GRAVEL.—Extensive gravel areas occur at several places, the locations and approximate areas of which are marked on the map, but not their outline in detail. Some of the gravel deposits are glacial in origin; others, estuary and beach deposits; and those west, and in the vicinity of Lake Judson, worked over or repiled glacial material. A great part of the gravel was found in low sections; but the gravel in Canada and that just east of Blaine is on high land. On the whole the gravel is a coarse variety in which are embedded many cobbles and boulders. It is now being used extensively for macadamizing roads; and, as the supply is inexhaustible, there is no reason why this region should not have first-class roads in a few years.

GARNETS.—Garnets are found on both beaches of the Lummi peninsula. They are obtained from the schists, principally from the mica schists. These schists on weathering and crumbling to dust on the highlands leave the harder garnets to be carried to the shore line by the streams. Here they are found in the beach sand. Garnets are also found at several places in the glacial deposits.

GOLD.—The black sand of the Lummi Bay beach carries gold; but there is so much verdigris in the water and sand that it is diffi-

cult to wash it out. So far there has not been enough found to make it pay.

Coal.—The coal seams examined in British Columbia were all coal of the lignitic type. At one place several tunnels had been made and coal had been mined at several different times, but had each been abandoned; the seams were too thin and the coal contained too much dirt. Probably by sinking shafts, thicker veins and a better quality of coal could be obtained.

The Eocene formation in the vicinity of Bellingham contains several coal-seams of workable coal; but a study of them and of the mines of the region was not made by the writer. A description of them, however, may be found in Professor Landes's report.[13]

SOIL.

The soil is very variable. In the glacial overwash regions it may vary from a few inches of loam to sand, gravel and clay all in the same dooryard. On the highlands east of Blaine, except in the sand and gravel districts, it is usually good. In the Sumas valley about Sumas City it is so light that it is blown from stumps, leaving the roots bare. In the immediate vicinity of Sumas City and lake it is deep, and ranges from a dark black muck to peat, from six inches to three feet in thickness. In all the swamp areas it is decayed peat.

The region is fast becoming a farming section.

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[13] Loc. cit., part I, p. 47.

SOME ANIMALS DISCOVERED IN THE FOSSIL BEDS OF KANSAS.

By CHARLES H. STERNBERG, Lawrence, Kan.

FOR many years past the writer of this paper has given his entire time to the collection and preparation for exhibit of fossils from several Western states, giving much time to the rich fields of western Kansas, so prolific in fine examples of ancient vertebrate life. Some mention of some of the best finds made within the last few years and where these have gone, many being lost forever for any Kansas museum, is worthy of record.

A complete skeleton of a new plesiosaur was found by the writer's son on the Hathaway ranch, on Beaver creek, Logan county, and which is now in the museum of the University of Kansas, having been mounted by the very competent preparator, Mr. H. T. Martin.

A nearly complete skeleton of *Portheus colossus*, of Cope, collected on Robinson's cattle ranch, in Logan county, within a stone's throw of the stable, is now mounted in the American Museum, at New York, and is said to be the best example of a fossil fish in any museum in the world.

There have also been sent to this museum from the Kansas fields eight other splendid specimens, including a very fine skull of the great ram-nosed *Tylosaurus* and the skeleton of a smaller form of *Portheus*. This has enabled that museum to restore and mount a nearly complete skeleton procured some years ago from Mr. W. O. Bourne, of Scott City, Kan., in which the head was distorted. This fine skull was found on Butte creek, 100 feet above where the writer had previously, in 1881, found as good a one, which is now in the Museum of Comparative Zoology, at Cambridge, Mass.

To Vassar College was sent a fine skeleton of *Clidastes* and also one of *Platecarpus*, both from Logan county.

To the Carnegie Museum, at Pittsburg, Pa., much material has been sent, including the most complete skeleton of *Protostega* ever found in the Kansas chalk-beds. This great turtle measured ten feet between the front paddles. There was also sent this museum a fine skeleton of the great predaceous fish, *Portheus colossus*.

To the British Museum has gone quite a collection, including a nearly complete skeleton of the great broad-handed lizard, *Platecarpus coryphœus*, a nearly complete skeleton of a *Pteranodon*, with the best skull that the writer has ever collected. There was also

included a fine pair of fins with pectoral arches connecting them of the well-armed snout-fish, *Protosphyræna*. Each fin, enameled and sharp as a knife, with forty teeth, is three feet in length. What must have been a strong and effective weapon of offense or defense is shown in a skull of this same fish, with its long, bony rostrum, oval in section and terminating in a sharp point. In addition to this dagger, fixed at the end of the head, the snout-fish possessed eight sharp, lancet-shaped teeth that projected forward. When the sharp point of the rostrum was driven into the victim's side these lancets widened the rent, till the animal's head could be forced into the breach up to its eye-rims, while their forward slant enabled the head to be quickly withdrawn for a fresh attack. Even the Kansas mosasaurs, who were no mean fighters themselves, must have avoided this great fighter among fishes.

A nearly complete skeleton of this same lizard is displayed in the museum of the University of Iowa. This was a large specimen, twenty-five feet in length, with the bones well bedded in the natural chalk.

The finest saurian ever found on any of the writer's expeditions came from the Mendenhall pasture, on Hackberry creek, in Gove county. The specimen was complete, except for the upper portion of the head. The massive jaws are present, and the bones generally are beautifully preserved, and so little distorted by pressure that the specimen can be given an open mount. Even the breast-bone and the cartilaginous ribs are present, this being the first time that these bones have been found in the remains of this animal. This fine specimen of *Platecarpus coryphæus* was sent to the Roemer Museum, at Hildersheim, near Hanover, Germany.

The first restoration of a *Platecarpus* skeleton ever attempted in the United States, the material being from Kansas beds, was sent to Doctor Krantz, a dealer of Bonn, Germany. With this went the material for an open mount of the Kansas rhinoceros, *Teleoceras fossiger*, from the Sternberg quarry, near Long Island, Kan.

There has been sent to the Munich Museum a complete set of lower jaws and also a number of inferior tusks of *Mastodon productus* (Cope).

The same museum possesses an unusual specimen of an ancient shark, *Oxyrhina mantelli*, found on Hackberry creek, Gove county, Kansas, in 1890. The remarkable thing about this specimen is that the vertebral column, though of cartilaginous material, was almost complete, and that the large number of 250 teeth were in position. When Chas. R. Eastman, of Harvard, described this

specimen, it proved so complete as to destroy nearly thirty synonyms used to name the animal, and derived from many teeth found at various former times. In addition to the above-mentioned vertebrate fossils, the writer has gathered many of lesser perfection or importance, as well as everything that came in his way illustrative of the life of former geologic times. The beds of Kansas have proved to be rich territory and to possess material of very great scientific interest, as is evidenced by the desire of the various museums mentioned above to secure fine illustrative examples of this ancient Kansas fauna.

The discovery and collection of these has been a constant source of joy and pleasure, entirely aside from any financial value they hold. On the other hand, it has been a very great disappointment that these things, of such great scientific interest, had to leave the state. Instead of finding a natural home at the University, the museums of the capital, or with the educational institutions of the state, they are scattered in other states, or even across the sea. Moreover, the finding of each new and valuable specimen reduces the probability of finding more in the years to come. The writer has tried to bring to a successful issue several movements through which the results of his collecting expeditions in Kansas would remain within the boundaries of the state—within the district where the huge and strange forms lived their lives. To his regret he has so far failed.

IV.

BIOLOGICAL PAPERS.

"List of Species of Hymenoptera Collected by the University of Kansas Entomological Expeditions of 1902, 1903, 1904, 1905, and 1906."
By F. H. Snow, University of Kansas, Lawrence.

"Results of the Entomological Collecting Expedition of the University of Kansas to Pima County, Arizona, in June and July, 1906."
By F. H. Snow, University of Kansas, Lawrence.

"List of Species of Coleoptera Collected in New Mexico by the Entomological Expeditions of the University of Kansas."
By F. H. Snow, University of Kansas, Lawrence.

"Contributions towards a Catalogue of Insects of Kansas, Resulting from Personal Collecting."
By Elbert S. Tucker, University of Kansas, Lawrence.

"Notice of some New Elements in Uintacrinus."
By H. T. Martin, University of Kansas, Lawrence.

"Additions to the List of Kansas Birds."
By F. H. Snow, University of Kansas, Lawrence.

"Soils and Bacteria."
By L. C. Wooster, State Normal School, Emporia.

"Notes on the Kansas Bird List."
By D. E. Lantz, Washington, D. C.

"Additions and Corrections to the List of Kansas Mammals."
By D. E. Lantz, Washington, D. C.

"Is the Gila Monster a Venomous Reptile?"
By F. H. Snow, University of Kansas, Lawrence.

"Notes on the Birds in the Baboquivari Mountains During the Months of June and July."
By L. A. Adams, University of Kansas, Lawrence.

"Food Habits of Kansas Lizards and Batrachians."
By F. A. Hartman, Wichita.

"Certain Conditions to be Met by Insect Collectors."
By Elbert S. Tucker, University of Kansas, Lawrence.

"Additions to the List of Kansas Coleoptera for 1906."
By W. Knaus, McPherson.

LIST OF SPECIES OF HYMENOPTERA

Collected in Arizona by the University of Kansas Entomological Expeditions of 1902, 1903, 1904, 1905, and 1906.

By F. H. Snow, University of Kansas, Lawrence.

THE determinations of species not already in the collection of the University of Kansas were made by Mr. H. L. Viereck, of the Academy of Natural Sciences of Philadelphia, assisted in certain families by Profs. H. T. Fernald, A. D. MacGillivray, and T. D. A. Cockerell, and Mr. C. T. Brues, to all of whom grateful acknowledgments are hereby tendered. There are still a considerable number of species not yet reported, which will be published at a later date. The localities are given in connection with each species. Oak Creek Canyon camp was made at Thomas's ranch, twenty miles southwest of Flagstaff, in Coconino county, altitude, 6000 feet; the camp at the base of Humphrey's Peak, in Coconino county, was at an altitude of 9500 feet; Congress Junction is in Yavapai county, 125 miles south of Ash Fork, altitude, 3000 feet; the Bill Williams Fork camp, was near Tappan's ranch, on the dividing line between Mojave and Yuma counties, altitude, 1000 feet; San Bernardino ranch is in the southeast corner of Arizona, in Cochise county, our camp being located eighteen miles east of Douglas, altitude, 3750 feet. Tucson and the Baboquivari Mountain camps are in Pima county, at an altitude of 3100 feet and 3750 feet.

Family Tenthredinidæ.

Atomocera ruficollis Norton. Oak creek, 1 specimen.
Hylotoma conspiculata Macgillivray, new species. Oak creek, 1 specimen.
Pristiphora siskiyouensis Marlatt. Oak creek, 1 specimen.
Pteronus coloradensis Marlatt. Oak creek, 1 specimen.
Selandria media Norton. Oak creek, 1 specimen.
Tenthredo variegatus Norton. Oak creek, 11 specimens.
xanthus Norton. Oak creek, 7 specimens.
undetermined species. Oak creek, 1 specimen.

Family Siricidæ.

Cephus cinctus Norton. Oak creek, 1 specimen.
Sirex albicornis Harris, var. californicus Norton. 4 specimens.

Family Evaniidæ.

Gasteruption pexplexus Cresson. Oak creek, 1 specimen.

Family ICHNEUMONIDÆ.

Ichneumon allapsus Cresson. Humphrey's Peak, at base and summit, 3 specimens.
animosus Cresson, var. rubellus Cresson. 1 specimen.
arizonensis Viereck, new species. Oak creek, 1 specimen.
citrinifacialis Viereck, new species. Oak creek, 2 specimens.
hemimelanarus Viereck, new species. Oak creek, 1 specimen.
humphreyi Viereck, new species. Humphrey's Peak, at base, 1 specimen.
lætus Brulle. Oak creek, 1 specimen.
longulus Cresson. Oak creek, 1 specimen; San Bernardino ranch, 3.
maurus Cresson. Oak creek, 1 specimen.
nigrosignatus Viereck, new species. Oak creek, 1 specimen.
vittifrons Cresson. Oak creek, 1 specimen.
Hemiteles lathroscopoides Viereck, new species. Oak creek, 4 specimens.
Pezomachus homalommoides Viereck, new species. Oak creek, 1 specimen.
Cryptus albotarsis Cresson. Oak creek, 1 specimen.
consobrinus Viereck, new species. Oak creek, 1 specimen.
politicalypterus Viereck, new species. San Bernardino ranch, numerous specimens.
Theronia fulvescens mellipennis Viereck. Oak creek, 10 specimens.
Pimpla annulipes Brulle. Oak creek, 1 specimen.
pedalis Cresson. Oak creek, 1 specimen.
Ophion purgatum Say. Baboquivari, 1 specimen.
Glypta egregiafovea Viereck, new species. Oak creek, one specimen.
Nototrachys ejunoidus Say. Oak creek, 1 specimen.
reticulatus Cresson. Oak creek, numerous specimens.
texanus Cresson. Oak creek, numerous specimens.
Bassus lætatarius Fab. Oak creek, two specimens.
Thyreodon morio Fab., race transitionalis Vier., new race. Oak creek, 2 specimens.
Paniscus geminatus Say. Oak creek, Bill Williams fork, Baboquivari, 1 specimen at each place.
Amblyteles hudsonicus Cresson. Oak creek, 1 specimen.
nubivagus Cresson. Humphrey's Peak, at base, 1 specimen.

Family BRACONIDÆ.

Chelonus altitudinis Viereck, new species. San Bernardino ranch, 2 specimens.
exogyrus Viereck, new species. Bill Williams fork and San Bernardino ranch, 1 specimen at each camp.
nucleolus Viereck, new species. Oak creek, 1 specimen.
texanoides Viereck, new species. Bill Williams fork, 1 specimen.
Agathis vulgaris Cresson. San Bernardino ranch, 1 specimen.
Crassomicrodus nigricaudus Viereck, new species. San Bernardino ranch.
Iphiaulax cinnabarinus Viereck, new species. Bill Williams fork, 1 specimen.
faustus Cress. Bill Williams fork, 2 specimens.
perepicus Viereck, new species. Bill Williams fork, 2 specimens; San Bernardino ranch, 2 specimens.
propinquus Viereck, new species. Oak creek, 1 specimen.
rugator Say. Bill Williams fork, 5 specimens.
Vipio erythrus Viereck, new species. Bill Williams fork, 2 specimens.

Family ENCYRTIDÆ.

Copidosoma gelechiæ Howard. Oak creek, 1 specimen.

Family PERILAMPIDÆ.

Perilampus cyaneus Brulle. Oak creek, 2 specimens.
hyalinus Say. Oak creek, 1 specimen.
Euperilampus opacus Ashmead. Oak creek, 1 specimen.

Family CHALCIDIDÆ.

Leucospis affinis Say. Oak creek, 1 specimen; Congress Junction, 1 specimen.
bicincta Viereck, new species, 1 specimen.
sulcata Westw. Oak creek, 2 specimens.
Stomatoceras, undetermined species. Congress Junction, 1 specimen.
Spilochalcis torvina Cresson. Oak creek, 2 specimens.
Chalcis flavipes Fab. Oak creek and San Bernardino ranch, 1 specimen at each camp.
Acanthochalcis argenteomaculata Ashm. Bill Williams fork, Congress Junction, San Bernardino ranch, and Tucson, numerous specimens.

Family FIGITIDÆ.

Eucoila impatiens Say. Oak creek, 1 specimen.
Figites coloradensis Ashm. Oak creek, 1 specimen.

Family SCELIONIDÆ.

Scelio venata Brues, new species. Baboquivari, 1 specimen.

Family DIAPRIDÆ.

Family CHRYSIDIDÆ.

Ceratopria, undetermined species. Oak creek, 1 specimen.
Notozus marginatus Patton. Oak creek, one specimen.
Holopyga horus Aaron. Oak creek, 1 specimen.
Tetrachrysis cæruleus Fab. Oak creek, 1 specimen; Tucson, 16.
intricata Brulle. Congress Junction. 1 specimen.
lauta Cress. Oak creek, 6 specimens.
tripartita Aaron. Oak creek and Tucson, 1 specimen at each place.
Metapochia, undetermined species. Oak creek, 1 specimen.
Parnopes westcotti Mell. and Brues. Bill Williams fork, 1 specimen.

Family FORMICIDÆ.

Camponotus castaneus Latr., var. americanus Mayr. Oak creek, 4 specimens.
lævigatus Smith. Oak creek, 1 specimen.
maculatus Latr., var. mccooki Forel. Oak creek, 4 specimens.
Formica fusca Linn., var. subpolita Mayr. Bill Williams fork and San Bernardino ranch, several specimens each.
var. neoclara Emery. Tucson, 2 specimens.
var. argentata Wheeler. Baboquivari, 1 speceimen.

Family DORYLIDÆ.

Labidus mexicanus Smith. San Bernardino ranch, 1 specimen.

Family MYRMICIDÆ.

Pogonomyrmex barbatus Smith. Congress Junction, numerous specimens.
barbatus Smith, var. nigrescens Wheeler. Cactus Plain, 7 specimens.
californicus Buckley. Baboquivari and Bill Williams fork, 1 specimen at each place.
occidentalis Cresson. Oak creek, numerous specimens.

Family MUTILLIDÆ.

Mutilla ægina Cresson. Oak creek, 8 specimens; San Bernardino ranch, 1 specimen.
bellona Cresson. Oak creek, 3 specimens; Humphrey's Peak, 1 specimen.
californica Rad. Oak creek, 13 specimens; Baboquivari, 1 specimen.
fulvohirta Cresson. Baboquivari, 1 specimen.
gloriosa Sauss., var. Congress Junction, Bill Williams fork, San Bernardino ranch, Baboquivari, several specimens.
montivaga Cress. San Bernardino ranch, 1 specimen.
oajaca Blake. San Bernardino ranch, 12 specimens; Tucson, 4 specimens.
ochracea Blake. Congress Junction, 1 specimen.
orcus Cresson. Congress Junction, Oak creek and Bill Williams fork, 1 specimen at each camp; Baboquivari and Tucson, several specimens; San Bernardino ranch, 21 specimens.
pacifica Cress. Bill Williams fork, 1 specimen.
propinqua Cress. San Bernardino ranch, 1 specimen.
sackenii Cress. Congress Junction, 2 specimens; Bill Williams fork, 21 specimens.
snoworum Cockerell and Fox. Oak creek, 1 specimen.

Photopsis belfragei Bdv. Tucson, 2 specimens; Baboquivari, 1 specimen.

Brachycistis glabrella Cress. San Bernardino ranch, 6 specimens; Tucson, 1 specimen.

Family TIPHIIDÆ.

Tiphia tarda Say. Bill Williams fork, Oak creek, Congress Junction, and San Bernardino ranch, 2 specimens in each camp.

Paratiphia albilabris Spin. Oak creek and Bill Williams fork, 5 specimens in each camp; Tucson, many specimens.

Family SCOLIIDÆ.

undetermined species. Oak creek, 1 specimen.

Scolia fervida Burm. Congress Junction, Oak creek, Bill Williams fork, San Bernardino ranch, and Baboquivari, numerous specimens each.
new species. Bill Williams fork, 1 specimen.

Discolia hæmatodes Burm. Bill Williams fork, 1 specimen; Oak creek, 5 specimens.

Elis dives Prov. Bill Williams fork, numerous specimens; San Bernardino ranch, 1 specimen.
pilipes Sauss. Oak creek and Baboquivari, 1 specimen in each place.
pollenifera Vier., var. *a*, new species. Bill Williams fork, 2 specimens.
plumipes Drury. Bill Williams fork, numerous specimens; Baboquivari, 1 specimen.
xantiana Sauss. Bill Williams fork, 1 specimen.

Family MYZINIDÆ.

Plesia interrupta Say. Oak creek, very numerous specimens.
frontalis Cresson. Congress Junction, Bill Williams fork, and Baboquivari, numerous specimens.
hamata Say. Oak creek, numerous specimens.

Family EUMENIDÆ.

Eumenes bollii Cress. Oak creek, 5 specimens; Congress Junction, San Bernardino ranch, Tucson, and Baboquivari, 1 each.
coloradensis Cress. Oak creek, many specimens.
Odynerus annulatus Say. Congress Junction, Oak creek, and Bill Williams fork, numerous specimens; San Bernardino ranch and Baboquivari, 2 each; Flagstaff, 1; Tucson, many specimens, in some cases the males showing the female pupa of the Coleopteron, Xenos peckii Kirby, protruding from a ventral segment.
anormis Say. Oak creek, 6 specimens; Tucson, 18.
arizonensis Cam. Congress Junction, 1 specimen.
behrensii Cress. Humphrey's Peak, 3 specimens.
birenimaculatus Sauss. Humphrey's Peak, 2 specimens.
bustamenti Sauss. Oak creek, 3 specimens.
capra Sauss. Oak creek, 30 specimens.
hidalgi Sauss. Oak creek and San Bernardino ranch, 1 specimen each.
iturbidi Sauss. Oak creek, 1 specimen; Baboquivari, 3.
pratensis Sauss. Congress Junction, 4 specimens; Bill Williams fork and San Bernardino ranch, 2 each.
reflexus Cress. Oak creek, 1 specimen.
taos Cress. Congress Junction and Oak creek, 1 specimen each; Tucson, 8.
texensis Sauss. Congress Junction, 2 specimens.
tigris Sauss. Humphrey's Peak and Oak creek, several specimens from each locality.
tuberculiceps Sauss. Humphrey's Peak, 2 specimens; Oak creek, 20 specimens.
toltecus Sauss. Congress Junction and Oak creek, numerous specimens; Tucson, 8; Baboquivari, 2.
Pterochilus 5-fasciatus Say. San Bernardino ranch, 1 specimen.

Family VESPIDÆ.

Polybia flavitarsus Sauss. Oak creek and Baboquivari, many specimens each.
Polistes aurifer Sauss. Oak creek, 3 specimens; Baboquivari, several specimens.
flavus Cress. Congress Junction, Bill Williams fork, and Baboquivari, numerous specimens at each locality.
navajoe Cress. Congress Junction, 1 specimen; Oak creek and Baboquivari, many specimens each.
texanus Cress. Bill Williams fork, 50 specimens; Baboquivari, numerous specimens.
Vespa diabolica Sauss. Oak creek, 3 specimens.
occidentalis Cress. Oak creek, many specimens.

Family CEROPALIDÆ (POMPILIDÆ.)

Pepsis boguei Fox. Oak creek, 4 specimens; San Bernardino, 1 specimen; Tucson and Baboquivari, several specimens.
chrysothemis Lucas. Congress Junction, 4 specimens; San Bernardino ranch, 1 specimen; Tucson, several specimens.
cinnabarina Lucas. Oak creek, 2 specimens; San Bernardino ranch, 1 specimen; Tucson and Baboquivari, several specimens.
domingensis St. Farg. Oak creek, 2 specimens.
formosa Say. San Bernardino ranch, Bill Williams fork, and Tucson, numerous specimens.
marginata Beauv. Oak creek, one specimen; Congress Junction, San Bernardino ranch, Baboquivari, and Tucson, numerous specimens.
montezuma Smith. Oak creek, 6 specimens; San Bernardino ranch, 2 specimens.
ornata St. Farg. Congress Junction, Bill Williams fork, Tucson, and Baboquivari, numerous specimens; San Bernardino ranch, 1 specimen.
pallidolimbata Lucas. San Bernardino ranch, 1 specimen.
Ceropales fraternus Smith. Oak creek, 5 specimens.
Cryptocheilus conicus Say. Oak creek, 2 specimens.
undetermined species. Oak creek, 1 specimen.
Pedinaspis planatus Fox. Congress Junction, 1 specimen.
Anoplius algidus Sm. Oak creek, 3 specimens.
apiculatus Sm. Bill Williams fork, 2 specimens; Tucson, 1 specimen.
ferrugineus Say. Bill Williams fork, 1 specimen; Oak creek, 7; Tucson, 1; Baboquivari, 1.
fulgidus Cresson. Bill Williams fork, 1 specimen.
ingenuus Cress. San Bernardino ranch, 1 specimen.
interruptus Say. San Bernardino ranch, 4 specimens.
marginatus Say. Oak creek, 1 specimen.
philadelphicus St. Farg. San Bernardino ranch, 4 specimens.
relativus Fox. San Bernardino ranch, 1 specimen.
scelestus Cress. San Bernardino ranch, 1 specimen; Tucson, 2.
subviolaceus Cress. Bill Williams fork, 1 specimen.
tenebrosus Cress. Tucson, 1 specimen.
new species. Bill Williams fork, 1 specimen; Tucson, 1.
new species. Congress Junction, 1 specimen.
Aporus fasciatus Sm. Tucson, 1 specimen.
Priocnemis flammipennis Sm. Oak creek, 1 specimen; San Bernardino ranch, 6; Tucson, several specimens.
heiligbrodtii Cress. Humphrey's Peak and Oak creek, numerous specimens each.
terminatus Say. Congress Junction, Oak creek, and San Bernardino ranch, 1 specimen at each camp; Tucson, several specimens.
Agenia acceptus Cress. Tucson, 1 specimen.
Melanaporus dubius Fox. Oak creek, 2 specimens.
Mygnimia mexicana Cress. Congress Junction, 1 specimen; Oak creek, 1; San Bernardino ranch, 6; Humphrey's Peak, numerous specimens.

Family SPHECIDÆ.

Ammophila aberti Hald. Congress Junction, 3 specimens; Bill Williams fork, 4; Tucson, 1.
argentifrons Cress. Oak creek, 5 specimens; Tucson, 1.
communis Cress. Oak creek, numerous specimens.
gryphus Smith. Oak creek, numerous specimens.
luctuosa Smith. Oak creek, 1 specimen.
macra Cress. Oak creek, numerous specimens.
pruinosa Cress. Bill Williams fork, 7 specimens; San Bernardino ranch, 1; Tucson, 1.
strenua Cress. Oak creek, 1 specimen; Baboquivari, 1.
varipes Cress. Humphrey's Peak and Oak creek, several specimens in each locality.
vulgaris Cress. Humphrey's Peak and Oak creek, 1 specimen in each locality.
xanthoptera Cam. Oak creek, numerous specimens.
undetermined species. Oak creek, 3 specimens.

Pelopæus cementarius Drury. Congress Junction, Oak creek, Bill Williams fork, and San Bernardino ranch, numerous specimens in each locality.
servillei Lep. Congress Junction, Oak creek, Bill Williams fork, and Tucson, several specimens each.

Chalybion cæruleum Linn. Oak creek, 1 specimen; San Bernardino ranch, 3; Tucson, several specimens.

Chlorion cæruleum Drury. Congress Junction, Oak creek, Bill Williams fork, San Bernardino ranch, Tucson, and Baboquivari, numerous specimens in each locality.

Isodontia azteca Sauss. Oak creek, numerous specimens; Baboquivari, 2.

Sphex ashmeadi Fernald. Bill Williams fork, numerous specimens; Congress Junction, 1; San Bernardino ranch, 3; Tucson and Baboquivari, several specimens.
decolorata Blake. Oak creek and Baboquivari, numerous specimens in each locality.
decolorata Blake, var. baboquivari, several specimens.
ichneumonea Fabr. Oak creek, abundant specimens; Humphrey's Peak, at base, 1 specimen; Baboquivari, 3.
lucæ Sauss. Oak creek, 5 specimens; Tucson, 2.
pennsylvanica Linn. Oak creek, abundant specimens.

Sceliphron texanum Cress. Oak creek, 2 specimens.

Harpactopus abdominalis. Oak creek, 4 specimens.
rufiventris Cress. Oak creek, 7 specimens; San Bernardino ranch, 1 specimen.

Parasphex ferrugineus Fox. Congress Junction and Bill Williams fork, 3 specimens at each camp.

Prionyx striatus Smith. Bill Williams fork, 6 specimens; Baboquivari, 1.
thomæ Fabr. Oak creek, abundant specimens; Bill Williams fork, 2; San Bernardino ranch, 1; Baboquivari, several specimens.

Family LARRIDÆ.

Astata nevadica Cress. San Bernardino ranch, 2 specimens; Tuscon, 1.
nubecula Cress. Tucson, 1 specimen.
unicolor Say. Oak creek, 3 specimens; San Bernardino, 2.
Plenoculus propinquus Fox. Oak creek, 1 specimen.
Lyroda subita Say. Oak creek and San Bernardino ranch, 1 specimen in each locality.
Notogonia argentata Beauv. Oak creek, 1 specimen; Tucson, 1.
nigripennis occidentalis Vier. Bill Williams fork and San Bernardino ranch, 1 specimen in each locality; Baboquivari, 9.
Tachytes abdominalis Say. San Bernardino ranch, 1 specimen.
distinctus Smith. Bill Williams fork, 1 specimen.
fulviventris Cress. Congress Junction, 1 specimen; Oak creek, 11; Baboquivari, 3.
obscurus Cress. Bill Williams fork, 2 specimens; Oak creek, 5; Tucson, 3.
pepticus Say. Bill Williams fork, 3 specimens; San Bernardino ranch, 1; Baboquivari, numerous specimens.
spatulatus Fox. Oak creek, 5 specimens; Baboquivari, several.
Tachysphex propinquus Vier. Oak creek, 4 specimens.

Family BEMBECIDÆ.

Stizus godmani Cam. Bill Williams fork, 1 specimen; Oak creek, 2.
grandis Say. Tucson, 1 specimen.
unicinctus Say. Tucson, 1 specimen.
Bembex amœna Hdl. Oak creek, 5 specimens.
fasciata. Humphrey's Peak, at base, and Oak creek, numerous specimens each; San Bernardino ranch and Tucson, 1 each.
nubilipennis Cress. Oak creek and San Bernardino ranch, numerous specimens; Flagstaff and Tucson, 1 each.
sayi Cress. Bill Williams fork and Oak creek, 6 specimens in each locality; Congress Junction, 1; Baboquivari and Tucson, 3 each.
troglodytes Hdl. Bill Williams fork and Oak creek, 1 specimen in each locality.
u-scripta Fox. Bill Williams fork, 17 specimens.
Stictia pictifrons Smith. Oak creek, 20 specimens; Tucson, 1.
Microbembex monodonta Say. Bill Williams fork, Oak creek, Tucson, and Baboquivari, numerous specimens at each place.
pulchella Cress. Oak creek, 2 specimens.
ventralis Say. Oak creek, abundant; San Bernardino ranch, Congress Junction, and Baboquivari, 1 specimen in each locality.

Family NYSSONIDÆ.

Gorytes bipunctatus Say. Oak creek, 2 specimens.
costalis Cress. Oak creek, 1 specimen.
eximius Prov. Bill Williams fork, 1 specimen.
spilopterus Hdl. Congress Junction, 2 specimens; Oak creek and San Bernardino ranch, 1 each.
Paranysson texanus Cress. Tucson, 4 specimens.

Family TRYPOXYLONIDÆ.

Trypoxylon arizonensis Fox. Bill Williams fork, 4 specimens.
tridendatum Packard. Congress Junction, 2 specimens; San Bernardino ranch, 1; Tucson and Baboquivari, 8 each.

Family PHILANTHIDÆ.

Eucerceris canaliculatus Say. Bill Williams fork, 5 specimens; San Bernardino ranch, 3.
rubripes Cress. Oak creek, 15 specimens.
unicornis Patton. Oak creek, 6 specimens.

Cerceris acanthophilus V. & C. Congress Junction, 12 specimens; Bill Williams fork, 4; Oak creek, 6; Tucson, numerous.
biungulata Cress. Oak creek, 1 specimen.
ferruginior Viereck and Ckll. Oak creek, 5 specimens; Bill Williams fork, 1; Tucson, many.
fasciata Cress. Oak creek, 3 specimens.
femur-rubrum V. & C. Congress Junction, 1 specimen.
macrosticta V. & C. Oak creek, 2 specimens.
nasica V. & C. Oak creek, 2 specimens.
platyrhina V. & C. Oak creek, 1 specimen.
rinconis V. & C. Congress Junction, 1 specimen; Bill Williams fork, 6; Tucson, 4.
sexta Say. Humphrey's Peak, 1 specimen.

Philanthus albifrons Cress. Humphrey's Peak, 3 specimens; Oak creek, 2.
crabroniformis Smith. Congress Junction and Bill Williams fork, numerous specimens; Oak creek, 3; San Bernardino ranch, 1.
punctatus Say. Oak creek, numerous specimens; Bill Williams fork, Congress Junction, and Baboquivari, 1 specimen in each locality; Tucson, numerous specimens.
punctatus cockerelli Dunn. Oak creek, 3 specimens.
new species. Oak creek, 3 specimens.

Aphilanthops taurulus Ckll. Congress Junction, 10 specimens.
quadrinotatus Ashmead. Flagstaff, 1 specimen.
new species. Flagstaff, 1 specimen.

Family MIMESIDÆ.

Mimesa punctata Fox. Oak creek, 4 specimens.
unicincta Cress. Bill Williams fork, 1 specimen.

Family PEMPHREDONIDÆ.

Stigmus inordinatus Fox. Oak creek, 1 specimen.
Pemphredon inordinatus Say. Oak creek, 1 specimen.

Family CRABRONIDÆ.

Crabro bellus Cress. Oak creek, 1 specimen.
chrysarginus. Oak creek, 14 specimens.
decemmaculatus Say. Oak creek, 20 specimens.
dilectus Cress. Oak creek, 8 specimens.
imbutis Fox. Oak creek, 5 specimens.
interruptus St. Farg. Oak creek, 1 specimen.
nigrifrons Cress. Humphrey's Peak, 2 specimens.
odyneroides Cress. Oak creek, 5 specimens.
packardii Cress. Oak creek, 14 specimens.

Thyreopus coloradensis Packard. Humphrey's Peak, 2 specimens.

Family OXYBELIDÆ.

Oxybelus cornutus Say. Oak creek, 50 specimens.
emarginatus Say. Oak creek, 3 specimens; Bill Williams fork, 1.
lætus Say. Oak creek, 3 specimens.
4-notatus Say. Oak creek, 50 specimens.
Notoglossa emarginata Say. Oak creek and Tucson, 2 specimens each.

Family ANDRENIDÆ.

Agapostemon melliventris Cress. Congress Junction, 6 specimens.
nigricornis Fab. Congress Junction, 2 specimens; Tucson, 1.
tricolor St. Farg. Oak creek, numerous specimens.
texanus Cress. Bill Williams fork, Oak creek, Congress Junction, and Tucson, numerous specimens.

Family HALICTIDÆ.

Proteraner ranunculi Robt. Oak creek, 1 specimen.
Sphecodes, four undetermined species. Oak creek, three species; Congress Junction, one species.
Halictus ligatus Say. Oak creek, 10 specimens; Tucson, 4.
Colletes americana Cress. Humphrey's Peak, several specimens; Tucson and Baboquivari, 1 each.
consors Cress. Oak creek, 1 specimen; Baboquivari, 3; Tucson, 25.

Family PROSOPIDÆ.

Prosopis affinis Sm. Oak creek, several specimens.
ruidosensis Ckll. Oak creek, 1 specimen.
ten new and undetermined species, Oak creek and Humphrey's Peak, at base.

Family NOMIIDÆ.

Nomia foxii D. T. Oak creek, 2 specimens; Tucson, many specimens.
nevadensis Cress. San Bernardino ranch and Bill Williams fork, several specimens.

Family PANURGIDÆ.

Rhophitoides fimbriatus Cress. Humphrey's Peak, 1 specimen.
Halictoides oryx Vier. Oak creek, 1 specimen.
Pseudopanurgus rugosus Robt. Oak creek, 1 specimen.
Panurginus innuptus Ckll. Oak creek, 2 specimens.
perlævis Ckll. Oak creek, 1 specimen.
four new and undetermined species.
Perdita—seven new and undetermined species. Bill Williams fork and Oak creek.

Family ANTHOPHORIDÆ.

Centris atripes Mocsary. San Bernardino ranch, several specimens; Tucson and Baboquivari, 4 each.
morsei marginata Fox. San Bernardino ranch, 1 specimen.
rhodopus Ckll. Bill Williams fork, many specimens; Tucson and Baboquivari, several each.
Anthophora montana Cress. Oak creek, 1 specimen.
smithii Cress. Tucson, 2 specimens.
urbana Cress. Humphrey's Peak and Oak creek, several specimens each; Tucson, 2.

Family ANTHOPHORIDÆ.

Anthophora walshii Cress. Oak creek, several specimens.
two new species. Congress Junction.
Amegilla californica Cress. Oak creek, 2 specimens.
cleomis Ckll. Oak creek, 4 specimens.
Clisodon terminalis Cress. Humphrey's Peak and Oak creek, 1 specimen in each locality.
Dasiapis ochracea Ckll. Several specimens.
Diadasia australis Cress. Tucson, 1 specimen.
diminuta Cress. Oak creek and Bill Williams fork, several specimens in each locality.
enavata Cress. Baboquivari, 1 specimen.
rinconi Ckll. Bill Williams fork, Oak creek, and Baboquivari, 1 specimen each.
Tetralonia (Synhalonia) fuscotincta Ckll., new species. Oak creek, 1 specimen.
lippiæ Ckll. Oak creek, 3 specimens.
lippiæ, subspecies sublippiæ Ckll., new subspecies. Oak creek. 1 specimen.
Xenoglossa patricia angustior Ckll. Congress Junction, 1 specimen.
pruinosa Say. Oak creek, 1 specimen.
Melissodes agilis Cress. Oak creek, many specimens.
agilis, var. subagilis Ckll. Oak creek, numerous specimens.
aurigenia Cr. Oak creek, numerous specimens.
communis Cress., var. Oak creek and Bill Williams fork, numerous specimens.
confusa Cress. Humphrey's Peak, at base, several specimens.
duplocincta Ckll., new species. Bill Williams fork, numerous specimens; Tucson, 3.
epicharina Ckll., new species. Oak creek, 1 specimen.
var. *a*. Oak creek, 1 specimen.
gilensis Ckll. Oak creek and Bill Williams fork, several specimens; Tucson and Baboquivari, 2 each.
grindeliæ Ckll. Oak creek, numerous specimens.
var. Oak creek, 1 specimen.
hexacantha Ckll., new species. Oak creek, 1 specimen.
var. *a*. Oak creek, 2 specimens.
var. *b*. Oak creek, 1 specimen.
var. *c*. Oak creek, 1 specimen.
intermediella Ckll., var. San Bernardino ranch and Oak creek, numerous specimens.
menuacha Cress. Oak creek and Humphrey's Peak, at base, many specimens.
montana Cress. Oak creek, numerous specimens.
nigrosignata Ckll., new species. Oak creek, 1 specimen.
var. pallidisignata Ckll. Oak creek, 2 specimens.
pallidicincta Ckll. Bill Williams fork and Oak creek, several specimens.
prælauta Ckll., new species. Oak creek, 1 specimen.
semitristis Ckll., new species. Oak creek, 1 specimen.
tristis Ckll. Oak creek and Tucson, several specimens.
tenuitarsis Ckll., new species. Oak creek, 1 specimen.

Family MELECTIDÆ.

Nomada texana Cress. Oak creek, 1 specimen.
two new species. Bill Williams fork, 3 specimens.
Phileremus?, undetermined species. Oak creek, 1 specimen.
Ericrocis lata Cress. Bill Williams fork, numerous specimens.
Epeolus lunatus Say. Oak creek, numerous specimens.
occidentalis Cress. Oak creek and San Bernardino, numerous specimens.
three undetermined species. Oak creek.
Triepeolus verbesinæ Ckll. Bill Williams fork, 1 specimen.
five new and undetermined species. Oak creek.

Family STELIDÆ.

Stelis rudbeckiana Ckll. Oak creek, numerous specimens.
Ceolioxys alternata Say. Oak creek, numerous specimens.
menthæ Ckll. Bill Williams fork, 1 specimen; Tucson, 25.
modesta Sm. Oak creek, 2 specimens.
octodentata Say. Oak creek, numerous specimens; Tucson, 2.
porteræ Ckll. Oak creek, 2 specimens.
ribis Ckll. Oak creek, 3 specimens.
rufitarsus Sm. Oak creek, 1 specimen.
sayi Robt. Oak creek, 2 specimens.
texana Cress. Oak creek, 2 specimens.
two undetermined species. Oak creek, several specimens each.

Family MEGACHILIDÆ.

Osmia mandibularis Cress., var. Humphrey's Peak, at base, 1 specimen.
undetermined species. Oak creek, several specimens.
Heriades gracilior Ckll. Oak creek, 4 specimens.
Ashmeadiella bigeloviæ Ckll. Bill Williams fork, numerous specimens.
meliloti Ckll. Oak creek, 10 specimens.
rotundiceps Cress. Oak creek, 4 specimens.
Anthidium emarginatum Say. Humphrey's Peak and Oak creek, several specimens.
maculifrons Sm. Oak creek, 1 specimen; Tucson, several.
maculosum Cress. Oak creek, Humphrey's Peak, at base, and Tucson, several specimens each.
Megachile agustini Ckll. Oak creek, numerous specimens.
avara Cress. Oak creek, numerous specimens.
brevis Say. San Bernardino ranch, numerous specimens.
lanuginosa Sm. (= brevis Say.) Oak creek.
cleomia Ckll. Oak creek, 3 specimens.
comata Cress. Oak creek, 3 specimens.
fidelis Cress. Oak creek, several specimens.
near inimica Cress. Oak creek, several specimens.
latimana. Oak creek, 3 specimens.
optiva Cress? Oak creek, several specimens.
perbrevis Cress. Oak creek, several specimens.
pereximia Ckll. Bill Williams fork, 1 specimen.
pugnata Say. Oak creek, numerous specimens.
relativa Cress. Oak creek, several specimens.

Family MEGACHILIDÆ.

Megachile texana Cress. Oak creek, San Bernardino ranch, and Bill Williams fork, several specimens.

vidua, race monaidum Ckll. One specimen.

Ceratina, undetermined species. Oak creek and Bill Williams fork, 1 specimen each.

undetermined species. Oak creek, 3 specimens.

Family XYLOCOPIDÆ.

Xylocopa californica Cress. Oak creek, San Bernardino ranch, Baboquivari, and Tucson, many specimens in each locality.

micans. Oak creek, many specimens.

new species. Bill Williams fork, Tucson, and Baboquivari, several specimens each.

undetermined species. Oak creek, 4 specimens.

Family BOMBIDÆ.

Protoxæa gloriosa Fox. San Bernardino ranch, 10 specimens.

Oxæa tristis Gribodo. San Bernardino ranch, 8 specimens.

Psithurus insularis Sm. Oak creek, 1 specimen.

Bombus bifarius Cress. Oak creek and Humphrey's Peak, at base, 1 specimen each.

dorsalis Cress. Oak creek, 5 specimens.

flavifrons Cress. Humphrey's Peak, several specimens.

howardi Cress. Oak creek and Humphrey's Peak, several specimens.

morrisonii Cress. Oak creek, many specimens.

sonorus Say. San Bernardino ranch and Tucson, many specimens; Baboquivari, 1 specimen.

Family APIDÆ.

Apis mellifica Linn. Abundant at all the camps.

SUMMARY OF FAMILIES AND SPECIES OF HYMENOPTERA.

Tenthredinidæ	8	Sphecidæ	29
Siricidæ	2	Larridæ	14
Evaniidæ	1	Bembecidæ	13
Ichneumonidæ	29	Nyssonidæ	5
Braconidæ	12	Trypoxylonidæ	2
Encyrtidæ	1	Philanthidæ	21
Perilampidæ	3	Mimesidæ	2
Chalcididæ	7	Pemphredonidæ	2
Figitidæ	2	Crabronidæ	10
Scelionidæ	1	Oxybelidæ	5
Diapriidæ	1	Andrenidæ	4
Formicidæ	6	Halictidæ	8
Dorylidæ	1	Prosopidæ	12
Myrmicidæ	4	Nomiidæ	1
Mutillidæ	15	Panurgidæ	16
Tiphiidæ	3	Anthophoridæ	47
Scoliidæ	8	Melectidæ	16
Myzinidæ	3	Stelidæ	12
Chrysididæ	8	Megachilidæ	27
Eumenidæ	19	Xylocopidæ	4
Vespidæ	7	Bombidæ	9
Ceropalidæ	34	Apidæ	1

Totals: Families, 44; species, 435.

RESULTS OF THE ENTOMOLOGICAL COLLECTING EXPEDITION

Of the University of Kansas to Pima County, Arizona, in June and July, 1906.

By F. H. Snow, University of Kansas, Lawrence.

This paper also includes Arizona material of former expeditions not previously identified, the location being given in each instance.

THE twenty-fifth collecting expedition in charge of the writer spent nine days in camp on the ranch of Mr. Thomas C. Kurtz, one and a half miles north of the railroad station at Tucson. The members of the party, in addition to the director, were Leverett A. Adams, for several years assistant in the department of zoology in the University of Kansas, now a member of the faculty of the State Normal School, at Greeley, Colorado, and S. E. Crumb, a student of the junior class. In the vicinity of this camp 3214 specimens were collected during the nine days, of which more than 2000 belong to the order of Hymenoptera. On July 3 the collecting party was increased by the arrival of Mr. Eugene Smyth, of Topeka, who had accompanied the writer on four preceding expeditions. On July 4 we started by wagon for Sycamore canyon, also called Brown canyon, in the southern portion of the Baboquivari mountains, and located our camp at a distance of sixty miles southwest of Tucson. This entire region is a typical desert area, and we found no small difficulty in obtaining a suitable supply of drinking water. At this second camp we collected insects for three weeks—from July 6 to 26—securing over 11,000 specimens, which, added to the Tucson material, made a total of 15,000 specimens as the result of the entire period of less than five weeks of actual work. At the second camp the Coleoptera took first place in the number of species and specimens collected, amounting to nearly one-half of the entire material. In regard to the scientific value of this material, Mr. Charles Liebeck, of Philadelphia, to whom I submitted many species of the Coleoptera which I was unable to identify from our previous collections, made the following statement: "The usual handicap, lack of Mexican material and synoptical tables in the Biologia Centrali-Americana, has hampered me more with this lot than with any other I have ever handled, due to the great number of apparent new species; and I must say that your 1906 catch certainly shows the finest lot of species I ever handled in one consignment.

Arizona is evidently a very rich field, and many possibilities are yet in store. I think it safe to assert that nearly all of those species (nearly sixty in number) marked simply as 'undetermined' are undescribed, and I can most surely state that they are not, or have not yet been, included in the United States fauna."

One of the most interesting captures among the Coleoptera at our second camp, was a limited number of specimens of the rare *Amblychila baroni* Rivers, which was found among the rocks near the summit of the mountain ridges between which our camp was situated—from 400 to 500 feet above the bottom of the canyon.

The altitude of the Baboquivari camp is 3750 feet above sea-level. The vegetation is largely of the usual type of the arid regions of the United States—many forms of cactus, yucca, agave or meschal, mesquite, and greasewood—and in the bottom of the canyon are trees of considerable size of the sycamore, walnut, and live oak. There were three quite copious thunder-showers during the three weeks of our stay, but in no case was there sufficient precipitation to cause the slightest run of water in the dry bed of the canyon. My hearty appreciation is hereby expressed of the most efficient services of my associates, Messrs. Adams, Crumb, and Smyth. Mr. Adams, in addition to his energetic work in collecting insects, also made a collection of birds, numbering 34 species, a list of which is contributed by him to the program for this meeting of the Academy.

I.—LIST OF COLEOPTERA.

For valuable services in the determination of species I am indebted to Mr. Charles Liebeck, of Philadelphia, and Mr. H. C. Fall, of Pasadena, Cal. I am also under obligations to Mr. A. B. Wolcott, of Chicago, for efficient aid in the family Cleridæ.

The numbers are those of Henshaw's lists.

When no locality is appended, the Baboquivari mountains are intended.

Family CICINDELIDÆ.

Amblychila baroni Rivers.
12 Tetracha carolina Linn. Tucson.
57 Cicindela lemniscata Lec.
wickhami W. Horn.
64*b* 16-punctata Kl.

Family CARABIDÆ.

139 Calosoma semilæve Lec.
213 Pasimachus mexicanus Gray.
218 punctulatus Hald.
220 Scarites subterraneus Fab., var. californicus Lec. Tucson; San Bernardino ranch, 1905.

Family CARABIDÆ.

275 Clivina bipustulata Fab. San Bernardino ranch, 1905.
345 Bembidium lugubre Lec.
timidum Lec.
454 Tachys vivax Lec.
557 Pterostichus subcordatus Lec. San Bernardino ranch, 1905.
672 Amara californica Dej.
683 musculus Say.
Calathus, new species near opaculus Lec.
746? behrensii Mann.
771 Platynus brunneomarginatus Mann., var. bicoloratus Germ.
772 extensicollis Say, var. San Bernardino ranch, 1905.
two new species?.
866 Tetragonoderus fasciatus Hald.
875 Lebia majuscula Chd.
876 atriceps Lec.
882 viridis Say.
916 Axinopalpus fusciceps Lec.
931 Plochionus timidus Hald.
940 Cymindis cribricollis Dej.
960 Helluomorpha texana Lec.
961 ferruginea Lec.
984 Brachynus fidelis Lec.
986 carinulatus Mots.
two undetermined species.
991 Chlænius ruficauda Chd.
1008 Chlænius leucoscelis Chev.
new species.
1047 Oodes elegans Lec.
1057 Piosoma setosum Lec.
1070 Discoderus robustus Horn.
1071 amœnus Lec.
1112 Harpalus clandestinus Lec.
1134 Selenophorus palliatus Fab.
1125 pedicularius Dej.
1140 Stenolophus conjunctus Say.
1179 Anisodactylus opaculus Lec. Tucson.
1192 arizonæ Casey.
new species.
1214 Pseudomorpha angustata Horn.

Family DYTISCIDÆ.

1246 Laccophilus pictus Lap. At both camps.
1251 mexicanus Aube.
truncatus Mann. Tucson.
1306 Deronectes striatellus Lec.
æquinachialis Clark.
1413 Agabus lugens Lec.
1458 Rhantus flavogriseus Cr. San Bernardino ranch, 1905.
1459 binotatus Harr.
1461 atricolor Aube.
1495*a* Thermonectes nigrofasciatus Aube.
1497 marmoratus Hope. At both camps.

Family GYRINIDÆ.

1515 Gyrinus plicifer Lec. At both camps.
1533 Dineutes sublineatus Chev.

Family HYDROPHILIDÆ.

1587 Hydrophilus insularis Lap. Tucson.
1588 Tropisternus limbalis Lec.
1594 ellipticus Lec. Tucson.
1600 Berosus punctatissimus Lec.
1605 styliferus Horn.
1610 immaculatas Zimm. San Bernardino ranch, 1905.
1634 Philhydrus diffusus Lec.

Family SILPHIDÆ.

1705 Silpha truncata Say.

Family STAPHYLINIDÆ.

2059 Aleochara nitida Gray.
2164 Philonthus semiruber Horn.
2182 alumnus Er., var. atriceps Fauvel. San Bernardino ranch, 1905.
2495 Cryptobium pimerianum Lec. San Bernardino ranch, 1905.
2701 Osorius planifrons Lec.
Oxytelus, undetermined species.

Family SCAPHIDIIDÆ.

2980 Scaphisoma castaneum Mots.

Family PHALACRIDÆ.

Eustilbus viduus Casey. San Bernardino ranch, 1905.

Family COCCINELLIDÆ.

3046 Hippodamia convergens Guer. At both camps.
3065a Olla abdominalis Say. At both camps.
3083 Exochomus marginipennis Lec.
arizonicus Casey. Tucson.
9900 Thalassa montezumæ Muls. Tucson.
Hyperaspis centralis Muls.
undetermined species.
Scymnus virginalis Wickham.

Family ENDOMYCHIDÆ.

Epipocus subcostatus Gorham.

Family EROTYLIDÆ.

3219 Ischyrus 4-punctatus Oliv.

Family CRYPTOPHAGIDÆ.

Anobocœlus championi Sharp.

Family DERMESTIDÆ.

3418 Dermestes marmoratus Say.
3420 caninus Germ.
3423 carnivorus Fab.
3426 elongatus Lec. Tucson.
Cryptorhopalum obesulum Casey.

Family HISTERIDÆ.

3457 Hololepta cacti Lec. Tucson.
3487 Hister cœnosus Er.
undetermined species near abbreviatus Fab.
3516 vernus Say.
9932 lubricans Casey.
3576 Saprinus pectoralis Lec.
3605 neglectus Mars.
3608 lubricus Lec.
3610 fimbriatus Lec.

Family TROGOSITIDÆ.

3833 Trogosita virescens Fab.
3841 Tenebriodes sinuata Lec.
Hesperobænus yuccæ Sz.

Family PARNIDÆ.

3920 Dryops productus Lec. At both camps.

Family ELATERIDÆ.

4064 Anelastes drurii Kirby.
Adelocera mexicana Candize.
4090 Chalcolepidius smaragdinus Lec.
10035 behrensi Cand.
tartarus Fall.
snowi Casey. New species. Bill Williams fork, 1903.
idoneus Casey. New species. Bill Williams fork, 1903.
arizonicus Casey. New species. Bill Williams fork, 1903.
abdominalis Casey. New species. Bill Williams fork, 1903.
simulans Casey. New species. Bill Williams fork, 1903.
rectus Casey. New species. San Bernardino ranch, 1905.
ostentus Casey. New species. Congress Junction and Bill Williams fork, 1903.
[The above seven new species of Chalcolepidius are described from my material in the *Canadian Entomologist* for February, 1907.]
4092 Alaus lusciosus Hope.
4113 Cardiophorus tenebrosus Lec.
aptopoides Cand.
Horistonotus, new species.
4128 simplex Lec.
4135? Esthesopus præditus Horn.
4136 parcus Horn.
4137 dispersus Horn.
new species.
undetermined species.
Aptopus spadiceus?
Anchastus, undetermined species.
4181 Monocrepidius lividus De G.
4185 vespertinus Fab.

Family ELATERIDÆ.

4187 Monocrepidius lathoides Lec.
4188 sordidus Lec.
elegans. San Bernardino ranch, 1905.
4194 Dicrepidius corvinus Cand.
Ludius peninsularis Champ. ?
42772 hepaticus Germ.
Agriotes, undetermined species.
4306 Melanotus macer Lec.
4322 fissilis Say.
4323 communis Gyll.

Family BUPRESTIDÆ.

Agæocera, undetermined species.
4575*a* Psiloptera webbii Lec.
Dicerca, undetermined species. Tucson.
4636 Chrysobothris octocola Lec.
4656 gemmata Lec.
10085 merkelii Horn.
4672 Thrincopyge ambiens Lec.
4675 Polycesta velasco L. & G.
Acmæodera conoidea Fall.
4708 4-vittata Horn.
10107 delumbis Horn.
undetermined species. San Bernardino ranch, 1905.
4737 Agrilus addendus Cr.
4749 obolinus Lec.
undetermined species.

Family LAMPYRIDÆ.

4768 Lycus cruentus Lec.
4769 fernandezii Duges.
4772 Lycostomus loripes Chev.
4817 Pyropyga fenestralis Melsh. Tucson.
4845 Microphotus dilatatus Lec.
4862 Spathizus bicolor Lec.
Polemius, undetermined species.

Family MALACHIDÆ.

5013 Collops vittatus Say.
regularis Gorh. San Bernardino ranch, 1905.
5061 Attalus rufiventris Horn.
5077 Pristoscelis convergens Lec. San Bernardino ranch, 1905.

Family CLERIDÆ.

5131 Cymatodera puncticollis Bland.
5134 cylindricollis Chev.
5135 brunnea Mels.
5142 morosa Lec.
5151 ovipennis Lec.
peninsularis Schaeffer.

Family CLERIDÆ.

Cymatodera latefascia Schaeffer.
umbrina Fall.
subsimilis Wolcott. New species.
5164 Clerus spinolæ Lec.
Hydrocena cincta Spin.
5230 Necrobia rufipes Fab. Tucson.

Family PTINIDÆ.

10150 Ctenobium cinereum Horn.
5338 Sinoxylon simplex Horn.
5340 sericans Lec.
5354 Amphicerus fortis Lec.

Family SCARABÆIDÆ.

5432*a* Canthon corvinus Horn.
5437 indigaceus Lec.
5445 Copris remotus Lec.
5448 carolina Linn.
5461 Onthophagus velutinus Horn.
new species.
Atænius haroldi Steinbeil. San Bernardino ranch, 1905.
5529 Aphodius vittatus Say.
5581 Ochodæus biarmatus Lec.
5617 Trox punctatus Germ. Both camps.
5701 Diplotaxis popino Casey.
three undetermined species.
near tristis Kirby.
5713 mœrens Lec.
5722 atratula Lec.
Lachnosterna labidens Schaeffer?.
10261 vetula Horn.
10270 lenis Horn. San Bernardino ranch, 1905.
5804 Phytalus debilis Horn.
5809 Listrochelus scoparius Lec. B. and T.
5812 mucoreus Lec.
5832 Anomala centralis Lec.
5846 Pelidnota lugubris Lec.
5859 Cyclocephala longula Lec.
5862 villosa Burm.
comata Bates.
5865 dimidiata Burm.
5870 Ligyrus ruginasus Lec.
5891 Phileurus illatus Lec.
5893 Allorhina mutabilis Gory.
Gymnetis impius Fall.
5898 Euphoria verticalis Horn.
5903 devulsa Horn.
5907 leucographa Gory.
holochloris Fab.
5919 Cremastochilus ineptus Horn.
mexicanus Schaum.

Family CERAMBYCIDÆ.

5953 Mallodon dasystomus Say.
5955 serrulatus Lec.
5957 Derobrachus geminatus Lec.
6026 Hypexilis pallida Horn.
6032 Axestinus obscurus Lec.
6036 Osmidus guttatus Lec.
Peribacum reticolle Bates.
6039 Eburia ulkei Bland.
undetermined species.
6055 Elaphidion alienum Lec.
6059 inerne Newm.
6067 tenue Lec.
Aneflus, new species.
6076 protensus Lec.
6078 Eustroma validum Lec.
6105 Rhopalophora longipes Say.
6111 Elytroleptus ignitus Lec.
6115 Callichroma plicatum Lec.
6121 Stenaspis verticalis Serv.
6122 solitaria Say.
Metaleptus, new species.
6126 Tragidion annulatum Lec.
6135 Æthecerus latecinctus Horn.
6145 Oxoplus jocosus Horn.
10297 Crossidius blandi Casey. San Bernardino ranch, 1905.
6160 Ischnocnemis bivittatus Dup.
6370 Monilema appressum Lec.
6372 gigas Lec. Both camps.
6372 semipunctatum Lec.
6410 Cœnopœus palmeri Lec.
Leptostylus yuccæ Fall. New species. San Bernardino ranch, 1905.
6433 Dectes spinosus Say. Tucson.
6471 Ataxia crypta Say, var.
10324 Peritapnia fabra Horn.

Family CHRYSOMELIDÆ.

Lema longipennis Linell.
6571 balteata Lec.
6582 Euryscopa lecontei Cr. Both camps.
parvula Jac.
6584 Coscinoptera æneipennis Lec.
6589 mucorea Lec.
6593 Megalostomis pyropyga Lac.
6594 major Cr.
6596 Babia 4-guttata Oliv.
6596*b* tetraspilota Lec.
6597 Saxinis apicalis Lec.
scutellaris Schaeffer. New species. San Bernardino ranch, 1905. Described in the Bulletin Mus. Brooklyn Inst. Arts and Sciences, October, 1906.
10346 sonorensis Jac.

Family CHRYSOMELIDÆ.

6600 Urodera crucifera Lac.
Chlamys arizonensis Linell.
6605 Exema comspersa Mann.
Cryptocephalus simulans Schaeffer. San Bernardino ranch, 1905.
simulans Schaefer, var.
basalis Suffr., var.
6651 Griburius montezumæ Suffr.
6690 Pachybrachys atomarius Melsh.
new species.
undet. species.
6747*b* Paria 4-notata Say.
Nodonota arizonica Schaeffer. New species. San Bernardino ranch, 1905. Described in the Bulletin Mus. Brooklyn Inst. Arts and Sciences, October, 1906.
10356 Metachroma aterrimum Horn. San Bernardino ranch, 1905.
6774 Colaspis brunnea Fab., var. Tucson.
6787 Doryphora lineolata Stal.
6792 haldemani Rog.
6794 rubiginosa Rog.
6797 Zygogramma opifer Stal.
6798 continua Lec.
6811 dislocata Rog.
6813 tortuosa Rog.
6816 multiguttata Stal.
clathrata Jac.
new species.
Plagiodera purpurea Linell.
6836 Lina arizonæ Cr. Tucson.
Androlyperus, new species.
Andrector ruficornis Oliv. Tucson.
10383 Scelolyperus flaviceps Horn.
Triarius, new species, or possibly a color variety of T. lividus Lec.
6861 Diabrotica 12-punctata Oliv. Both camps.
6883 balteata Lec. Tucson.
two undetermined species.
Cneorane mexicana? Jacoby.
6916*a* Monoxia angularis Lec.
6933 Œdionychis lugens Lec., var.
10410 tenuilineata Horn.
extrema Harold.
two undetermined species.
6954 Disonycha abbreviata Melsh.
6962 Haltica carinata Germ., var. or perhaps a new species.
6966 obliterata Lec.
undetermined species.
7063 Microrhopala rubrolineata Mann.
Brachycoryne pumila Boh.
7098 Cassida bivittata Say.
undetermined species. San Bernardino ranch, 1905.
7106 Coptocycla lecontei Cr.
profligata Boh.

Family BRUCHIDÆ.

7137 Bruchus prosopis Lec. Tucson.
7149 amicus Horn. Both camps.

Family TENEBRIONIDÆ.

7183 Eurymetopon emarginatum Casey.
7200 Epitragus submetallicus Lec.
7204 pruinosus Horn.
7219 Zopherus tristis Lec.
7238 Cryptoglossa verrucosa Lec. Tucson.
7243 Centrioptera variolosa Horn. Both camps.
7251 Ologyptus anastomosis Say.
7255 Asida mancipata Horn.
7268 parallela Lec. Tucson.
7284*a* rimata Lec.
7307 Eusattus reticulatus Say.
7322 Eleodes carbonaria Say.
form soror Lec. San Bernardino ranch, 1905.
7324 quadricollis Esch. Both camps.
7325 humeralis Lec.
7327 extricata Say.
7331 longicollis Lec.
10560 wickhami Horn.
7339 nigrina Lec.
7360 subnitens Lec.
dissimilis, var. nevadensis Blaisdell.
new species.
7379 Argoporus costipennis Lec.
10568 alutacea Casey.
7392 Nyctobates subnitens Horn.
7552 Notibius gagates Horn.
7517 Platydema inquilinum Linell.
undetermined species, near ruficolle Lap.
10631 Strongylium atrum Champ.

Family CISTELIDÆ.

10647 Hymenorus grandicollis Champ.
10653 prolixus Casey.
10678 Telesicles caudatus Champ. San Bernardino ranch, 1905.

Family LAGRIIDÆ.

Statira defecta Schaeffer.
huachuchæ Schaeffer.

Family ŒDEMERIDÆ.

7739 Oxacis cana Lec.
7743 sericea Horn. San Bernardino ranch, 1905.

Family MORDELLIDÆ.

7760 Diclidia lætula Lec.
marginalis Say. San Bernardino ranch, 1905.
7847 Mordellistena, new species.

Family ANTHICIDÆ.

Stereopalpus impressicollis Casey?. San Bernardino ranch, 1905.
Notoxus curvitrichus Casey.
7938 Anthicus sturmii Laf.
7948 confinis Lec. Tucson.

Family MELOIDÆ.

8058 Macrobasis pupurea Horn.
8066 lauta Horn.
8067 tenella Lec.
8069 segmentata Say.
10733 tenuilineata Horn.
8089 insignia Horn. San Bernardino ranch, 1905.
8991 Epicauta pardalis Lec. Both camps.
alastor Skinner.
undetermined species.
8110 Pyrota postica Lec.
10748 Tegrodera latecincta Horn. Tucson.

Family RHIPIPHORIDÆ.

8183 Myodites scaber Lec.

Family OTIORHYNCHIDÆ.

8249 Eupagoderes sordidus Lec.
8250 argentatus Lec. Tucson.
8315 Pandeletejus cinereus Horn.
8338 Coleocerus marmoratus Horn.

Family CURCULIONIDÆ.

8373 Apion sordidum Smith.
8500 Lixus perforatus Lec.
10860 Dinocleus denticollis Casey.
8571 Endalus limatulus Gyll. San Bernardino ranch, 1905.
8603 Otidocephalus vittatus Horn.
8607 chevrolatii Horn.
8654 Anthonomus hirtus Lec. Tucson.
11056 Tychius hispidus Casey.
8749 Chalcodermus spinifer Horn.
8760 Acalles prosus Lec.
Cryptorhynchus, undetermined species.
Zascelis oblonga.
8807 Zygops seminiveus Lec.
8868 Baris strenua Lec. San Bernardino ranch, 1905.
8886 Pseudobaris farcta Lec.
Stictobaris, new species. San Bernardino ranch, 1905.

Family CALANDRIDÆ.

8973 Scyphophorus acupunctatus Gyll.
undetermined species.
Calandrid, undetermined genus and species, near Nyssonotus.
Sphenophorus, undetermined species, near oblitus Lec. San Bernardino ranch, 1905.
undetermined species, near mormonus Chittenden. San Bernardino ranch, 1905.

Family ANTHRIBIDÆ.

9221? Cratoparis lunatus Fab.
undetermined species.

SUMMARY OF FAMILIES AND SPECIES OF COLEOPTERA.

Cicindelidæ	5	Malachidæ	4
Carabidæ	45	Cleridæ	12
Dytiscidæ	11	Ptinidæ	4
Gyrinidæ	2	Scarabæidæ	39
Hydrophilidæ.	6	Cerambycidæ	34
Silphidæ	1	Chrysomelidæ	63
Staphylinidæ	7	Bruchidæ	2
Scaphidiidæ	1	Tenebrionidæ	29
Phalacridæ	1	Cistelidæ	3
Coccinellidæ	8	Lagriidæ	2
Endomychidæ	1	Œdemeridæ	2
Erotylidæ	1	Mordellidæ	3
Cryptophagidæ	1	Anthicidæ	4
Dermestidæ	5	Meloidæ	11
Histeridæ	9	Rhipiphoridæ	1
Trogositidæ	3	Otiorhynchidæ	4
Parnidæ	1	Curculionidæ	16
Elateridæ	35	Calandridæ	5
Buprestidæ	15	Anthribidæ	2
Lampyridæ	7		

Totals: Families, 39; species, 395.

II.—LIST OF LEPIDOPTERA.

My grateful acknowledgments for assistance in the determination of species in this order are hereby tendered to Dr. Henry Skinner, Dr. H. G. Dyar, Prof. John B. Smith, Dr. W. G. Dietz, Mr. W. D. Kearfott, and Mr. G. W. Taylor.

The locality is the Baboquivari, mountains unless otherwise stated.

Numbers according to Smith's check-list of 1903.

Family NYMPHALIDÆ.

103 Melitæa chara Edw.
113 definita Aaron.
137*a* Synchloe crocale Edw.
158 Pyrameis cardui Linn.
160*a* Junonia negra Feld.
182*a* Heterochroa californica Butl.
185 Apatura leilia Edw.
205 Neonympha rubricata Edw.

Family LIBYTHEIDÆ.

255*a* Libythea bachmani Kirtl.

Family ERYCINIDÆ.

257 Lemonias duryi Edw.
261 palmerii Edw.
265 Calephelis australis Edw.

Family LYCÆNIDÆ.

283 Thecla melinus Hbn.
303 blenina Hew.
311 leda Edw.
387 Lycæna isola Reak. Tucson.
388 gyas Edw. Tucson.
393 exilis Edw.
394 marina Reak.

Family PAPILIONIDÆ.

423 Catopsilia eubule Linn.
433 Colias cæsonia Stoll.
453 Terias mexicana Bdv.
454 nicippe Cram. Tucson.
469 Papilio philenor Linn.
473 bairdii Edw.
485 daunus Bdv.

Family HESPERIDÆ.

495 Copæodes waco Edw.
495*a* procris Edw.
604 Amblyscirtes ænus Edw.
620 Pyrgus nessus Edw.
occidentalis Skinner.
640 Nisoniades clitus Edw.
645 Systasea pulverulenta Feld.
649 Pholisora catullus Fabr.
652 ceos Edw.
661 Eudamus pylades Scudd.
666 hippalus Edw.
687 Heteropia melon Gdm. and Salv., var. arizonensis Skinner.

Family SPHINGIDÆ.

725 Amphion nessus Cram.
729 Deilephila lineata Fabr.

Family SATURNIIDÆ.

814 Agapema galbina Clem.

Family CERATOCAMPIDÆ.

829 Adelocephala heiligbrodtii Harv.

Family SYNTOMIDÆ.

Syntomeida benta Skinner. New species. Described in *Entomological News*, December, 1906.
866 Ctenucha venosa Wlk. Tucson.

Family ARCTIIDÆ.

921 Ptychoglene coccinea Hy. Edw.
950 Estigmene acræa Dru.
1005 Euchætias murina Stretch.
bolteri Stretch. San Bernardino ranch, 1905.
1016 Pygarctia elegans Stretch.
1038 Eupseudosoma involutum Sepp. San Bernardino ranch, 1905.
1041 Calidota zella Dyar.

Family AGARISTIDÆ.

1059 Alypiodes bimaculata H.-S.
1066 Copidryas gloveri G. & R.

Family NOCTUIDÆ.

Cyathissa quadrata Sm. New species.
1260 Perigæa albolabes Grt.
1359 Hadena indirecta Grt. Oak Creek canyon, 1904.
1372 smaragdina Neum.
1453 Laphygma flavimaculata Harv.
Aleptina flavomedia Sm. New species.
1642 Peridroma rudens Harv.
2148 Trichoclea decepta Grt. San Bernardino ranch, 1905.
2149 nova Sm. San Bernardino ranch, 1905.
2161 Leucania unipunctata Harv.
2478 Trileuca buxea Grt. Tucson.
2542 Schinia sexplagiata Sm. San Bernardino ranch, 1905.
2548 unimaculata Sm.
2563 tertia Grt. San Bernardino ranch.
accessa Smith. New species. San Bernardino ranch, 1905.
2645 Oxycnemis advena Grt.
2660 Neumœgenia poetica Grt.
2661 Narthecophora pulverea Sm. Tucson.
2688 Plusiodonta compressipalpis Gn.
Ogdoconta altura Barnes.
2811 Pleonectyptera habitalis Wlk.
new species.
2842 Erastria propera Grt.
2852 Azenia edentata Grt.
2863 Xanthoptera clausula Grt.
2864 semiflava Gn.
2869 Thalpochares daria Druce.
2871 fortunata Grt.
2872 perita Grt.
2877 Tripudia opipara Hy. Edw.
2905 Acontia expolita Grt.
2912 biplaga Gn.
2916 quadriplaga Sm.
2924 elegantula Harv. Tucson.
2933 libedis Sm.
alata Sm.
2937 Fruva fasciatella Grt.

Family Noctuidæ.

2946 Spragueia plumbifimbriata Grote.
2950 funeralis Grote.
2953 tortricina Zeller. Taken also at Tucson.
2971 Parora texana Sm.
Isogona segura Barnes.
3003 Euclidia dyari Sm.
3008 Melipotis nigrescens G. & R.
3009 pallescens G. & R.
3010 perlæta Hy. Edw.
3019 Cirrhobolina deducta Morr.
3020 mexicana Behr.
3021 vulpina Hy. Edw.
3191 Heteranassa fraterna Sm.
3192 minor Sm.
3202 Yrias clientis Grt.
3204 volucris Grt.
3205 repentis Grt.
strigalis Smith.
3235 Erebus odora Linn.

Family Notodontidæ.

Notodonta, new species.
Dasylophia zethus Druce. San Bernardino ranch, 1905. New to United States.
3396 Heterocampa lunata Hy. Edw. San Bernardino ranch, 1905.
pyrrha Druce.
3428 Gluphisia septentrionalis Wlk. San Bernardino ranch, 1905.
Notela jaliscana Schaus.
Hapigia xolotl Druce.

Family Liparidæ.

Archylus tener Druce.

Family Geometridæ.

3610 Coryphista meadii Pack. Oak Creek canyon, 1904.
3619 Phylace luteolata Hulst. Oak Creek canyon, 1904.
3638 Zenophleps lignicolorata Pack. Oak Creek canyon, 1904.
3680 Hydriomena mirabilata Grt. Oak Creek canyon, 1904.
3690 Cœnocalpe aurata Grt. Oak Creek canyon, 1904.
3691 magnoliata Gn. Oak Creek canyon, 1904.
3697 polygrammata Hulst. San Bernardino ranch, 1905.
3760 Cosymbia pannaria Gn. San Bernarnino ranch, 1905.
3796 Eois demissaria Hbn. San Bernardino ranch, 1905.
3805 ossularia Hbn. Taken also at San Bernardino ranch, 1905.
3808 balistaria Gn. San Bernardino ranch, 1905.
3809 rufescens Hulst. San Bernardino ranch, 1905.
3838 Chlorochlamys chloroleucaria Gn. San Bernardino ranch, 1905.
3857 Synchlora denticulata Walker. San Bernardino ranch, 1905.
3878 Fernaldella fimetaria G. & R.
3893 Chloraspilates bicoloraria Pack. San Bernardino ranch, 1905.
3916 Deilinia behrensaria Hulst., var? Oak Creek canyon, 1904; also, at San Bernardino ranch, 1905.

Family GEOMETRIDÆ.

3929 Sciagraphia punctolineata Pack.
3948 Macaria s-signata Pack. Taken also at San Bernardino ranch, 1905.
near mendicata Hulst. San Bernardino ranch, 1905.
4081 Alcis obliquaria Grote. San Bernardino ranch, 1905.
4085 haydenata Pack. Oak Creek canyon, 1904.
4096 Meris alticola Hulst. Oak Creek canyon, 1904.
4102 Tornos scolopacinarius Green. Tucson.
4103 abjectarius Hulst.
4106 Glaucina pygmeolaria Grt.
puellaria Dyar.
Sabulodes, undetermined species. San Bernardino ranch, 1905.
4276 Metanema vanusaria Strck. Oak Creek canyon, 1904.
4289 Stenispilates meskearia Pack. San Bernardino ranch, 1905.

Family LIMACODIDÆ.

4419 Euclea pænulata Clem.?
incisa Harr. San Bernardino ranch, 1905.
4436 Prolimacodes trigona Hy. Edw.
Limacodes oropeso.

Family MEGALOPYGIDÆ.

4448 Megalopyge opercularis S. & A.

Family PYROMORPHIDÆ.

4458 Triprocris fusca Hy. Edw.
4461 constans Hy. Edw.

Family THYRIDÆ.

Dysodia, new species.

Family PYRALIDÆ.

4629 Glaphyria reluctalis Hulst.
4634 Symphysa eripalis Grt. San Bernardino ranch, 1905.
simplicialis Kearfott. New species. San Bernardino ranch, 1905. Described in *Entomological News*, January, 1907.
4651 Diastictis fracturalis Zell.
4680 Agathodes monstralis Gn.
4692 Hellula undalis Fab. San Bernardino ranch, 1905.
4694 Terastia metriculosalis Gn.
4718 Loxostege helvialis Wlk. Both camps, and at San Bernardino ranch, 1905.
4729 albiceralis Grt. San Bernardino ranch, 1905.
4731 labeculalis Hulst.
4741 ophionalis Wlk. Bill Williams fork, 1903, and Tucson.
4766 Titanio helianthialis Murtf. Tucson and Bill Williams fork, 1903, and San Bernardino ranch, 1905.
4780 Phlyctænia extricalis Gn. San Bernardino ranch, 1905.
4827 Pyrausta tyralis Gn.
4849 Noctuelia thalialis Wlk.
4871 Elophila fulicalis Clem. Bill Williams fork, 1903, and San Bernardino ranch, 1905.
schaefferalis Dyar. Oak Creek canyon, 1904.

Family PYRALIDÆ.

4906 Acallis griphalis Hulst.
4914 Schœnobius sordidellis Zinck. San Bernardino ranch, 1905.
4917 mellinellus Clem. Bill Williams Fork, 1903, and San Bernardino ranch, 1905.
4924 Prionapteryx achatina Zell.
baboquivariella Kearfott. New species.
4964 Crambus coloradellus Fern.
near haustuellus. San Bernardino ranch, 1905.
new species.
4984 Thaumatopsis magnifica Fern.
4991 Ommatopteryx ocellea Haw. San Bernardino ranch, 1905, and Tucson.
4994 Argyria argentana Martyn.
5008 Dicymolomia metalliferalis Pack. San Bernardino ranch, 1905.
5021 Cacozelia basiochrealis Grt.
5024 Jocara dentilineella Hulst.
5027 Yuma trabalis Grt.
5029 Benta asperatella Clem.
5030 melanogrammos Zell.
5046 Attacapa callipeplella Hulst. San Bernardino ranch, 1905.
5164 Elasmopalpus lignocellus Zell. Tucson.
5176 Epischnia boisduvaliella Gn.? San Bernardino ranch, 1905.
5182 Getulia flavidorsella Rag.
5201 Melitara fernaldalis Hulst.
5206 Zophodia glaucatella Hulst.
polingella Dyar.
5230 Heterographis morrisonella Rag. San Bernardino ranch, 1905.
5253 Homœosoma electellum Hulst. San Bernardino ranch, 1905.
5263 Ephestioides gilvescentella Rag.
5278 Plodia interpunctella Hbn. San Bernardino ranch, 1905.
5279 Ragonotia dotalis Hulst. San Bernardino ranch, 1905.
5295 Saluria dichroella Rag.

Family PTEROPHORIDÆ.

5347 Alucita belfragei Fish. Tucson.

Family TORTRICIDÆ.

5410 Bactra furfurana Haw.
5484 Eucosma bolanderana Wlsm.
5533 pulveratana Wlsm. Bill Williams fork, 1903, and San Bernardino ranch, 1905.
5537 constrictana Zell. San Bernardino ranch, 1905.
5539 solicitana Wlk. San Bernardino ranch, 1905.
5541 strenuana Wlk. San Bernardino ranch, 1905.
5542 perplexana Fern. San Bernardino ranch, 1905.
5553 scudderiana Clem. San Bernardino, 1905.
5582 Cydia perangustana Wlsm. San Bernardino ranch, 1905.
5599 rœssleri Zell. San Bernardino ranch, 1905.
5639 Epinotia crispana Clem. Also at San Bernardino ranch, 1905.
5792 Archips virescana Clem. San Bernardino ranch, 1905.

Family YPONOMEUTIDÆ.

6040 Plutella maculipennis Curt. San Bernardino ranch, 1905.
yumatella Kearfott. New species. San Bernardino ranch, 1905. Described in *Canadian Entomologist*, January, 1907.

Family GELECHIIDÆ.

6160 Phthorimæa operculella Zell. Also at San Bernardino ranch, 1905.
6228 Gelechia albilorella Zell.
6233 paulella Busck.
6240 striatella Busck.
*6251 lindenella Busck. Also at San Bernardino ranch, 1905.
6345 Trichotaphe inversella Zell.
simpliciella Busck.
6366 Ypsolophus eupatoriellus Cham.

Family BLASTOBASIDÆ.

Holcocera arizoniella Kearfoot. New species. San Bernardino ranch, 1905. Described in *Canadian Entomologist*, January, 1907.

Family ŒCOPHORIDÆ.

6453 Ethmia marmorea Wlsm.

Family ELACHISTIDÆ.

6654 Scythris trivinctella Zell. Bill Williams fork, 1903, and San Bernardino ranch, 1905.

Family TINEIDÆ.

Amydrya confusella Dietz. San Bernardino ranch, 1905.
arizonella Dietz. San Bernardino ranch, 1905.
marjoriella Dietz. San Bernardino ranch, 1905.
crescentella Kearfott. New species. Described in *Canadian Entomologist*, January, 1907.
Setomorpha operosella Zell. San Bernardino ranch, 1905.
Eulepiste cockerellii Dyar. San Bernardino ranch, 1905.
7119 maculifer Wlsm.
7129 Acrolophus simulatus Wlsm.
7134 Anophora popeanella Clem. Bill Williams fork, 1903, and San Bernardino ranch, 1905.
7138 Orthologhus variabilis Wlsm. Also at Bill Williams fork, 1903, and San Bernadino ranch, 1905.
7139 Felderia filicicornis Wlsm.
7141 Pseudanophora davisellus Beut.

SUMMARIES OF FAMILIES AND SPECIES.

Nymphalidæ	8	Geometridæ	30
Libytheidæ	1	Limacodidæ	4
Erycinidæ	3	Megalopygidæ	1
Lycænidæ	7	Pyromorphidæ	2
Papilionidæ	7	Thyridæ	1
Hesperidæ	12	Pyralidæ	47
Sphingidæ	2	Pterophoridæ	1
Saturnidæ	1	Tortricidæ	12
Ceratocampidæ	1	Yponomeutidæ	2
Syntomidæ	2	Gelechiidæ	8
Arctiidæ	7	Blastobasidæ	1
Agaristidæ	2	Œcophoridæ	1
Noctuidæ	56	Elachistidæ	1
Notodontidæ	7	Tineidæ	12
Liparidæ	1		

Totals: Families, 29; species, 240.

III.—LIST OF HEMIPTERA-HETEROPTERA.

For the determination of species in this order the author is indebted to Mr. E. P. Van Duzee.

Numbers according to Uhler's check-list.

Family SCUTELLERIDÆ.

27 Sphyrocoris punctellus Stal.

Family CORIMELÆNIDÆ.

53 Corimelæna nitiduloides Wolff.
58 extensa Uhl.
64 nigra Dallas.

Family CYDNIDÆ.

75 Cyrtomenus mirabilis Perty.
104 Pangæus spangbergi Sign.?

Family PENTATOMIDÆ.

140 Perillus confluens H.-Sch.
146 Mineus strigipes H.-Sch.?
186 Brochymena arborea Say.
192 obscura H.-Sch.
201 Discocephala clypeata Stal.
Hymenarcys crassa Uhl.
294 Trichopepla semivittata Say.
300 Thyanta custator Fab. Tucson.
303 rugulosa Say, var.

Family COREIDÆ.

440 Pachylis gigas Burm.
446 Mozena lineolata H.-Sch.
447 lunata Burm.

Family COREIDÆ.

482 Acanthocephala granulosus Dallas.
493 Leptoglossus zonatus Dallas.
501 Narnia pallidicornis Stal.
snowi Van D. New species. San Bernardino ranch, 1905. Described in *Canadian Entomologist*, January, 1907.
527 Anasa armigera Say. Tucson.
507 Chelinidea vittigera Uhl. Also at Tucson.
560 Hyalymenus tarsatus Fab.
563 Alydus calcaratus Fab.
setosus Van D. New species.
587 Harmostes reflexulus Stal.
595 Corizus hyalinus Fab. Tucson.

Family BERYTIDÆ.

Jalysus wickhami Van D. New species.

Family LYGÆIDÆ.

658 Ligyrocoris sylvestris Linn.
715 Lygæus facetus Say.
743 bicolor H.-Sch.
752 reclivatus Say.
753 turcicus Fab.
759 Oncopeltus fasciatus Dallas.
Lygæosoma solida Uhl.

Family PYRRHOCORIDÆ.

766 Largus succinctus Linn.
773 Arhaphe carolina H.-Sch.
779 Dysdercus obliquus H.-Sch.

Family CAPSIDÆ.

847 Phytocoris eximius Reut.
860 Calocoris rapidus Say. Tucson.
863 superbus Uhl. Tucson.
864 fulvomaculatus De G. Tucson.
892 Lygus scutellatus Dist. Tucson.
902 Pœciloscytus basalis Reut. Tucson.

Family ARADIDÆ.

1106 Brachyrhynchus mœstus Stal.

Family PHYMATIDÆ.

1118 Phymata wolffii Stal.

Family NABIDÆ.

1144 Coriscus ferus Linn. Tucson.

Family REDUVIDÆ.

Sinea rileyi Montcl.
complexa Caud. At both camps.
1152 diadema Fab. Tucson.
1197 Diplodus exsanguis Stal. Tucson.
1209 Pindus socius Uhl.

Family Reduvidæ.

1212 Apiomerus subpiceus Stal.?, possibly immundus Bergr.
1214 crassipes Fab.
1218 ventralis Say.
spissipes Say.
longispinus Champ.
Homalocoris minutus Mayr.
1232 Rasahus thoracicus Stal.
1248 Conorhinus variegatus Drury.
maximus Uhl.
Reduvius senilis Van D. New species.

Family Hydrobatidæ.

1302 Hygrotrechus remigis Say.

Family Galgudidæ.

1357 Gelastocoris oculatus Fab.
undetermined species.

Family Belostomatidæ.

Pedinocoris sp. Tucson.

Family Notonectidæ.

1401 Notonecta mexicana Am. et S.

Family Corixidæ.

Corixa, two species.

SUMMARY OF FAMILIES AND SPECIES OF HEMIPTERA-HETEROPTERA.

Scutelleridæ	1	Aradidæ	1
Corimelænidæ	3	Phymatidæ	1
Cydnidæ	2	Nabidæ	1
Pentatomidæ	9	Reduviidæ	15
Coreidæ	14	Hydrobatidæ	1
Berytidæ	1	Galgulidæ	2
Lygæidæ	7	Belostomatidæ	1
Pyrrhocoridæ	3	Notonectidæ	1
Capsidæ	6	Corixidæ	2

Totals: Families, 18; species, 71.

IV.—LIST OF ORTHOPTERA.

The author hereby expresses his grateful acknowledgments to Mr. J. A. G. Rehn, of the Philadelphia Academy of Natural Sciences, for the determination of a large portion of the material in this order of insects. This list includes all the Arizona species collected by the expeditions of 1902, 1903, 1904, 1905, and 1906.

Family FORFICULIDÆ.

Apterygida linearis Esch. San Bernardino ranch.

Family BLATTIDÆ.

Pseudomops oblongata Linn. San Bernardino ranch.
Stylopyga orientalis Linn. San Bernardino ranch.
Homœogamia bolliana Sauss. Oak creek canyon, Baboquivari mountains.
erratica Rehn. New species. San Bernardino ranch, Baboquivari mountains.

Family MANTIDÆ.

Litaneutria minor Scudd. San Bernardino ranch, Baboquivari mountains, Bill Williams fork, Cactus plain.
Vates paracusis Sauss. Baboquivari mountains.
Stagmomantis limbata Hahn. Bill Williams fork, San Bernardino ranch.
gracilipes Rehn. New species. Baboquivari mountains.

Family PHASMIDÆ.

Diapheromera arizonensis Caud San Bernardino ranch.
Pseudosermyle truncata Caud. San Bernardino ranch.

Family ACRIDIIDÆ.

Tettix granulatus Kirb. Oak Creek canyon.
Clypeotettix schochii Bol. Baboquivari mountains.
Paratettix toltecus Sauss. Oak Creek canyon, Bill Williams fork, San Bernardino ranch, Tucson.
toltecus Sauss, race arizonus Hanc. San Bernardino ranch, Bill Williams fork, Tucson.
toltecus Sauss, form sonorensis Hanc. Oak Creek canyon, Bill Williams fork, Tucson.
Telmatettix aztecus Sauss. Bill Williams fork, Baboquivari mountains, Tucson.
Achurum acridodes Stal. Baboquivari mountains.
Mermiria bivittata Serv. San Bernardino ranch.
neomexicana Thom. Baboquivari mountains.
texana Brun. Oak Creek canyon.
admirabilis Uhl. San Bernardino ranch, Baboquivari mountains.
Syrbula fuscovittata Thom. San Bernardino ranch, Baboquivari mountains.
Acrocara maculipennis Scudd. San Bernardino ranch.
Eritettix variabilis Brun. San Bernardino ranch.
Bootettix argentatus Brun. Bill Williams fork.
Amphitornus ornatus McNeill. Oak Creek canyon, Baboquivari mountains.
Opeia testacea Scudd. San Bernardino ranch.

Family ACRIDIIDÆ.

Cordillacris pima Rehn. New species. Baboquivari mountains.
Orphulella compta Scudd. Bill Williams fork, San Bernardino ranch.
Gomphocerus clepsydra Scudd. Oak Creek canyon.
Boopedon fuscum Brun. San Bernardino ranch.
Psoloessa buddiana Brun. Baboquivari mountains.
maculipennis Scudd. Baboquivari mountains, San Bernardino ranch.
texana Scudd. Baboquivari mountains.
Stirapleura pusilla Scudd. Baboquivari mountains.
Ageneotettix australis Brun. Baboquivari mountains.
Aulocara elliotti Thom. San Bernardino ranch.
rufum Scudd. San Bernardino ranch, Baboquivari mountains.
Ligurotettix kunzei Caud. Bill Williams fork, Cactus plain.
Arphia aberrans Brun. Baboquivari mountains.
arcta Scudd. Oak Creek canyon.
crassa Brun. San Bernardino ranch.
Encoptolophus texensis Brun. San Bernardino ranch, Tucson.
Camnula pellucida Scudd. Oak Creek canyon, Humphrey's Peak, at base.
Hippiscus conspicuus Scudd. Baboquivari mountains.
corallipes Hald. Baboquivari mountains, San Bernardino ranch.
Scyllina calida Brun. San Bernardino ranch, Baboquivari mountains.
Leprus cyaneus Ckll. Baboquivari mountains.
Dissosteira carolina Linn. Oak Creek canyon.
Spharagemon collare Scudd., var. angustipenne Morse. San Bernardino ranch.
Lactista oslari Caud. Tucson.
Tomonotus aztecus Sauss. Baboquivari mountains, San Bernardino ranch.
ferrugineus Brun. Baboquivari mountains.
Derotmema delicatum Scudd. Bill Williams fork, San Bernardino ranch, Baboquivari mountains.
haydeni Thom. Flagstaff, San Bernardino ranch, Bill Williams fork.
Trepidulus rosaceus McNeill. Bill Williams fork.
melleolus Scudd. San Bernardino ranch.
Mestobregma plattei Thom. Baboquivari mountains.
rubripennis Brun. Baboquivari mountains.
Conozoa carinata Rehn. New species. Tucson, Baboquivari mountains.
sulcifrons Scudd. Bill Williams fork, Baboquivari mountains, Tucson.
Trimerotropis bruneri McNeill. Baboquivari mountains.
cyanipennis Brun. Oak Creek canyon.
fascicula McNeill. Oak Creek canyon, Humphrey's Peak, at base, Baboquivari mountains.
laticincta Sauss. San Bernardino ranch, Flagstaff.
modesta Brun. Oak Creek canyon.
snowi Rehn. New species. (Trans. Kan. Acad. Sci., vol. XIX, p. 223.) Congress Junction.
strenua McNeill. San Bernardino ranch.
vinculata Scudd. Oak Creek canyon, San Bernardino ranch, Tucson, Baboquivari mountains.
Circotettix undulatus Thom. Oak Creek canyon, Humphrey's Peak, at base.

Family ACRIDIIDÆ.

Anconia integra Scudd. Bill Williams fork.
Heliastes aridus Brun. Bill Williams fork, San Bernardino ranch, Congress Junction, Baboquivari mountains.
benjamini Caud. Baboquivari mountains.
minimus Scudd. Bill Williams fork.
Tytthotyle maculata Brun. Bill Williams fork.
Brachystola intermedia Brun. San Bernardino ranch.
Phrynotettix magnus Thom. San Bernardino ranch, Baboquivari mountains.
Paropomala cylindrica Brun. San Bernardino ranch.
Leptysma marginicollis Serv. Bill Williams fork.
Schistocerca shoshone Thom. Bill Williams fork, San Bernardino ranch.
vaga Scudd. Bill Williams fork, San Bernardino ranch, Tucson, Baboquivari mountains.
venusta Scudd. Oak Creek canyon.
Conalcœa huachucana Rehn. Baboquivari mountains.
Hesperotettix festivus Scudd. Tucson, Baboquivari mountains.
Æoloplus tenuipennis Scudd. Bill Williams fork.
Melanoplus aridus Scudd. San Bernardino ranch.
atlantis Riley. San Bernardino ranch, Baboquivari mountains.
brownii Caud. Baboquivari mountains.
canonicus Scudd. Bill Williams fork, Tucson.
differentialis Uhl. San Bernardino ranch.
femur-rubrum De G. San Bernardino ranch.
flavescens Scudd. Bill Williams fork.
flavidus Scudd. Oak Creek canyon, Bill Williams fork, San Bernardino ranch.
olivaceus Scudd. Oak Creek canyon.
spretus Uhl. Tucson, Baboquivari mountains.
thomasi Scudd. San Bernardino ranch.
yarrowi Thom. Bill Williams fork.
Phœtaliotes nebrascensis Thom. San Bernardino ranch.
Pœcilotettix sanguineus Scudd. Bill Williams fork.
Dactylotum pictum Thom. Baboquivari mountains.

Family LOCUSTIDÆ.

Hormilia elegans Scudd. San Bernardino ranch.
Arethæa constricta Brun. Baboquivari mountains, Tucson.
Scudderia furcifera Scudd. Oak Creek canyon.
mexicana Sauss. Tucson, Baboquivari mountains.
Amblycorypha huasteca Sauss. Oak Creek canyon.
Microcentrum laurifolium Linn. Oak Creek canyon.
Conocephalus mexicanus Sauss. Bill Williams fork.
Xiphidium fasciatum De G. San Bernardino ranch.
Capnobotes fuliginosus Thom. Congress Junction, San Bernardino ranch, Baboquivari mountains.
Eremopedes ballii Caud. Oak Creek canyon, Baboquivari mountains.
unicolor Scudd. San Bernardino ranch, Baboquivari mountains.
Plagiostira gracilis Rehn. New species. (Trans. Kan. Acad. Sci., vol. XIX, p. 227.) Bill Williams fork.

Family Locustidæ.

Ateloplus notatus Scudd. Bill Williams fork, Baboquivari mountains, Tucson.

Stenopelmatus oculatus Scudd. Oak Creek canyon, Humphrey's Peak, at base.

Ceuthophilus paucispinosa Rehn. New species. (Trans. Kan. Acad. Sci., vol. XIX, p. 227.) Oak Creek canyon.

Phrixocnemis franciscanus Rehn. New species. (Trans. Kan. Acad. Sci., vol. XIX, p. 228.) Humphrey's Peak, at base.

socorrensis Rehn. New species. (Trans. Kan. Acad. Sci., vol. XIX, p. 229.) Humphrey's Peak, at base.

Udeopsylla serrata Rehn. New species. (Trans. Kan. Acad. Sci., vol. XIX, p. 230.) Oak Creek canyon.

Family Gryllidæ.

Ellipes minuta Scudd. San Bernardino ranch.

Tridactylus apicalis Say. Bill Williams fork.

Nemobius neomexicanus Scudd. San Bernardino ranch.

Gryllus armatus Scudd. San Bernardino ranch, Baboquivari mountains, Tucson.

pennsylvanicus Burm. Bill Williams fork.

personatus Uhl. San Bernardino ranch.

Miogryllus lineatus Scudd. Baboquivari mountains.

Œcanthus californicus Sauss.? Tucson, Baboquivari mountains.

quadripunctatus Reut. Bill Williams fork, Oak Creek canyon, San Bernardino ranch.

SUMMARY OF FAMILIES AND SPECIES OF ORTHOPTERA.

Forficulidæ	1	Acridiidæ	90
Blattidæ	4	Locustidæ	18
Mantidæ	4	Gryllidæ	9
Phasmidæ	2		

Totals: Families, 7; species 128.

LIST OF COLEOPTERA COLLECTED IN NEW MEXICO BY THE ENTOMOLOGICAL EXPEDITIONS OF THE UNIVERSITY OF KANSAS.

By F. H. Snow, University of Kansas, Lawrence.

THE writer has conducted six expeditions to New Mexico for the purpose of collecting insects for the museum of the University of Kansas. These were all in the months of July and August, in the years 1880, 1881, 1882, 1883, 1884, and 1894. The first expedition had its headquarters eight miles north of the city of Santa Fé, in the Santa Fé canyon, at an altitude of 7000 feet above sea-level; the second expedition had its camp in Water canyon, twenty-five miles west of Socorro, where our work was prematurely closed by an invasion of Apache Indians; the third and fourth camps were located at the Gallinas canyon, less than a mile above the Las Vegas hot springs, at an altitude of 7000 feet; the fifth was along Walnut creek, a tributary of the Gila river, about twelve miles north of Silver City and three miles west of the "continental divide"; the sixth expedition had its headquarters in Hop canyon, in the Magdalena mountains, about thirty miles west of Socorro. The results of the last expedition have never been published, and it has been thought desirable to gather into a single list the combined results of the six expeditions to New Mexico.

The numbers are those of Henshaw's list.

Family Cicindelidæ.

16 Cicindela obsoleta Say. Gallinas canyon.
16*a* vulturina Lec. Gallinas canyon.
16*b* prasina Lec. Gallinas canyon.
18 longilabris Say. Santa Fe canyon.
19*a* unicolor Dej. Socorro.
20 nigrocærulea Lec. Gallinas canyon.
21 pulchra Say. Gallinas canyon. Socorro.
25*a* audubonii Lec. Gallinas canyon.
25*c* cimarrona Lec. Gallinas canyon, Socorro, Santa Fe canyon.
28 fulgida Say. Albuquerque.
32 vulgaris Say. Albuquerque, Gallinas canyon, Santa Fe canyon.
32*a* obliquata Kirby. Gallinas canyon.
33*a* oregona Lec. Gallinas canyon.
33*b* guttifera Lec. Santa Fe canyon.
35 hirticollis Say. Socorro.
36 cinctipennis Lec. Gallinas canyon.
36*a* imperfecta Lec. Gallinas canyon.

Family CICINDELIDÆ.

40 Cicindela punctulata Fab. Gallinas canyon, Santa Fe canyon, Socorro.
40*a* micans Fab. Gallinas canyon, Santa Fe canyon.
47 macra Lec. Socorro.
51 sperata Lec. Socorro, Albuquerque.
57 lemniscata Lec. Deming.
58*a* prætextata Lec. Socorro.
64*b* 16-punctata Kl. Gallinas canyon.

Family CARABIDÆ.

76 Omophron americanum Dej. Santa Fe canyon, Walnut creek.
86 Cychrus elevatus Fab. Santa Fe canyon, Gallinas canyon.
88 snowii Lec. Santa Fe canyon.
119 Carabus tædatus Fab. Santa Fe canyon, Gallinas canyon.
121 serratus Say. Santa Fe canyon.
127 Calosoma scrutator Fab. Gallinas canyon.
132 prominens Lec. Albuquerque.
133 peregrinator Guer. Albuquerque, Gallinas canyon, Water canyon.
133 form carbonatum Lec. Albuquerque.
136 triste Lec. Albuquerque, Water canyon.
137 obsoletum Say. Magdalena mountains, Gallinas canyon.
179 Notiophilus hardyi Putz. Gallinas canyon.
192 Nebria obliqua Lec. Santa Fe canyon, Walnut creek.
194 hudsonica Lec. Walnut creek.
195 sahlbergi Fisch. Gallinas canyon.
195 sahlbergi Fisch., var. Gallinas canyon.
215*a* Pasimachus costifer Lec. Gallinas canyon, Water canyon.
217 elongatus Lec. Gallinas canyon, Santa Fe canyon.
219 californicus Chd. Walnut creek.
232 Dyschirius globulosus Say. Santa Fe canyon.
287 Schizogenius depressus Lec. Walnut creek.
322 Bembidium longulum Lec. Santa Fe canyon.
343 transversale Dej. Santa Fe canyon, Gallinas canyon.
345 lugubre Lec. Santa Fe canyon, Gallinas canyon, Magdalena mountains.
347 striola Lec. Santa Fe canyon, Gallinas canyon, Magdalena mountains.
347 striola Lec., var. Walnut creek.
349 bimaculatum Kirby. Santa Fe canyon.
351 lucidum Lec. Santa Fe canyon, Gallinas canyon, Magdalena mountains.
358 picipes Kirby. Santa Fe canyon.
363 grapii Gyll. Gallinas canyon.
388 intermedium Kirby. Gallinas canyon, Santa Fe canyon.
412 connivens Lec. Santa Fe canyon.
414 assimile Gyll. Santa Fe canyon.
417 quadrimaculatum Linn. Santa Fe canyon.
new species, near incertum Mots. (*fide* Roland Hayward, May, 1904). Walnut creek.

Family CARABIDÆ

Bembidium new species, allied to grapei Gyll. (*fide* Roland Hayward, May, 1904). Gallinas canyon.
449 Tachys nanus Gyll. Gallinas canyon, Santa Fe canyon.
near tripuncatatus Say. Walnut creek.
461 incurvus Say. Santa Fe canon.
483 Trechus chalybeus Mann. Santa Fe canyon, Walnut creek.
504 Pterostichus protractus Lec. Santa Fe canyon.
506 longulus Lec. Santa Fe canyon, Gallinas canyon.
524 substriatus Lec. Water canyon, Gallinas canyon.
525 constrictus Say. Walnut creek.
583 luczotii Dej. Santa Fe canyon, Gallinas canyon.
618 Evarthrus torvus Lec. Gallinas canyon.
647 Amara latior Kirby. Santa Fe canyon.
664 fallax Lec. Walnut creek.
666 confusa Lec. Santa Fe canyon, Water canyon, Gallinas canyon, Magdalena mountains.
668 polita Lec. Santa Fe canyon.
669 erratica Sturm. Santa Fe canyon, Gallinas canyon.
670 interstitialis Dej. Gallinas canyon.
670 interstitialis Dej., var. Gallinas canyon.
676 terrestris Lec. Santa Fe canyon.
678 remotestriata Dej. Santa Fe canyon.
680 gibba Lec. Santa Fe canyon.
684 harpalina Lec. Water canon.
743 Calathus ingratus Dej. Santa Fe canyon.
749 advena Lec. Walnut creek.
751 dubius Lec. Magdalena mountains, Santa Fe canyon, Gallinas canyon.
758 Platynus nivalis Horn. Magdalena mountains, Santa Fe canyon, Water canyon.
766 sinuatus Dej., var. Santa Fe canyon.
771 brunneomarginatus Mann. Walnut creek.
771 brunneomarginatus Mann., var. Walnut creek.
772 extensicollis Say. Gallinas canyon.
800 cupripennis Say. Santa Fe canyon.
815 placidus Say. Santa Fe canyon, Gallinas canyon, Magdalena mountains.
822 quadripunctatus De G. Gallinas canyon.
823 bembidioides Kirby. Gallinas canyon.
842 Lachnophorus elegantulus Mann. Gallinas canyon.
843 Euphorticus pubescens Dej. Walnut creek.
872 Lebia grandis Hentz. Walnut creek.
875 majuscula Chd. Gallinas canyon.
882 viridis Say. Gallinas canyon.
891 scapula Horn. Walnut creek.
892 analis Dej., var. Walnut creek, Socorro.
893 fuscata Dej. Gallinas canyon.
895 scapularis Dej. Gallinas canyon.
902 bivittata Fab. Gallinas canyon.
914 Metabletus americanus Dej. Santa Fe canyon.

Family CARABIDÆ

919 Callida platynoides Horn. Walnut creek.
926 Philophuga viridicollis Lec. Gallinas canyon.
936 Pinacodera punctigera Lec. Walnut creek.
939 Cymindis laticollis Say. Santa Fe canyon, Gallinas canyon.
940 cribricollis Dej. Santa Fe canyon, Gallinas canyon.
Brachynus cinctipennis Chev. Albuquerque.
978 cordicollis Dej. Albuquerque.
985 tschernikhii Mann. Walnut creek.
new species. Walnut creek.
991 Chlænius ruficauda Chd. Walnut creek.
1010 obsoletus Lec. Walnut creek.
1021 pennsylvanicus Say. Albuquerque.
1054 Nothopus zabroides Lec. Albuquerque, Gallinas canyon.
1057 Piosoma setosum Lec. Magdalena mountains, Water canyon.
1059 Agonoderus lineola Fab. Albuquerque.
1068 Discoderus impotens Lec. Albuquerque.
1078 Harpalus autumnalis Say. Magdalena mountains, Socorro.
1080 retractus Lec. Santa Fe canyon, Albuquerque, Gallinas canyon.
1081 amputatus Say. Gallinas canyon.
1083 caliginosus Fab. Gallinas canyon, Albuquerque, Santa Fe canyon, Water canyon.
1087*a* compar Lec. Santa Fe canyon.
1089 spadiceus Dej. Gallinas canyon.
1091 fallax Lec. Gallinas canyon.
1094 herbivagus Say. Santa Fe canyon, Gallinas canyon.
1097 opacipennis Hald. Magdalena mountains, Gallinas canyon.
1099 ellipsis Lec. Water canyon, Santa Fe canyon.
1103 carbonatus Lec. Magdalena mountains.
1105 montanus Lec. Santa Fe canyon, Gallinas canyon.
1110 funestus Lec. Santa Fe canyon, Gallinas canyon, Water canyon, Magdalena mountains.
1111 oblitus Lec. Water canyon.
1112 clandestinus Lec. Socorro, Magdalena mountains.
1115 ochropus Kirby. Santa Fe canyon, Water canyon, Gallinas canyon.
1116 lustrans Casey. Water canyon.
1117 basilaris Kirby. Water canyon.
1122 cordatus Lec. Magdalena mountains.
1123 obliquus Horn. Magdalena mountains, Socorro.
undetermined species. Water canyon.
1125 Selenophorus pedicularius Dej. Santa Fe canyon, Gallinas canyon.
1140 Stenolophus conjunctus Say. Santa Fe canyon.
1142 cincticollis Lec. Gallinas canyon.
1145 ochropezus Say. Albuquerque.
1164 Tachycellus nigrinus Dej. Santa Fe canyon.
1199 Anisodactylus maculicornis Chd. Walnut creek.
1205 lætus Dej. Albuquerque.

Family AMPHIZOIDÆ.

1216 Amphizoa lecontei Matth. Santa Fe canyon.

Family HALIPLIDÆ.

1228 Cnemidotus callosus Lec. Gallinas canyon.

Family DYTISCIDÆ.

1243 Laccophilus decipiens Lec. Santa Fe canyon, Gallinas canyon.
1244 proximus Say. Santa Fe canyon.
1297 Cœlambus nubilus Lec. Santa Fe canyon, Gallinas canyon.
1306 Deronectes striatellus Lec. Santa Fe canyon, Gallinas canyon, Socorro, Water canyon.
1340 Hydroporus rivalis Gyll. Santa Fe canyon.
1370 vilis Lec. Santa Fe canyon, Gallinas canyon.
1389 Ilybius biguttalus Germ. Santa Fe canyon, Gallinas canyon, Water canyon.
1391 laramæus Lec. Santa Fe canyon, Gallinas canyon.
1400 Ilybiosoma regularis Lec. Gallinas canyon.
1406 Agabus cordatus Lec. Santa Fe canyon, Gallinas canyon.
1408 intersectus Cr. Santa Fe canyon.
1413 lugens Lec. Santa Fe canyon.
1423 semipunctatus Kirby. Santa Fe canyon.
1435 austinii Sharp. Santa Fe canyon.
1449 tristis Aube. Santa Fe canyon.
1459 Rhantus binotatus Harr. Santa Fe canyon, Gallinas canyon, Magdalena mountains.
1461 atricolor Aube. Walnut creek.
1495 Thermonectes ornaticollis Aube. Albuquerque.
1495*a* nigrofasciatus Aube. Albuquerque.
1496 basilaris Harr. Albuquerque.
1503 Cybister ellipticus Lec. Albuquerque.

Family HYDROPHILIDÆ.

1586 Hydrophilus triangularis Say. Gallinas canyon, Albuquerque.
1589 nimbatus Say. Gallinas canyon, Santa Fe canyon.
1591 glaber Hbst. Santa Fe canyon.
1592 californicus Lec. Water canyon, Santa Fe canyon.
1594 ellipticus Lec. Water canyon, Santa Fe canyon.
1613 Berosus infuscatus Lec. Gallinas canyon.
1620 Limnebius piceus Horn. Gallinas canyon.
1622 Laccobius ellipticus Lec. Santa Fe canyon.
1626 Philhydrus nebulosus Say. Santa Fe canyon.
1634 diffusus Lec. Gallinas canyon, Albuquerque, Santa Fe canyon.
1642 Hydrocombus fimbriatus Melsh. Santa Fe canyon.
1646 Hydrobius scabrosus Horn. Santa Fe canyon.
1653 fuscipes Linn. Santa Fe canyon.
1654 rufiventris Horn. Santa Fe canyon, Gallinas canyon.
1655 infuscatus Mots. Santa Fe canyon, Gallinas canyon.
1657 subcupreus Say. Santa Fe canyon.

Family SILPHIDÆ.

1698 Necrophorus marginatus Fab. Santa Fe canyon, Gallinas canyon, Water canyon.
1700 guttula Mots. Santa Fe canyon, Gallinas canyon.
1705 Silpha truncata Say. Santa Fe canyon, Gallinas canyon, Magdalena mountains.
1706 lapponica Hbst. Santa Fe canyon, Gallinas canyon, Water canyon.
1729 Choleva basillaris Say. Walnut creek.
1770 Anisotoma valida Horn. Gallinas canyon.
1782 Liodes globosa Lec. Walnut creek.

Family STAPHYLINIDÆ.

1996 Falagria cingulata Lec. Socorro.
Ætheta, three undetermined species. Gallinas canyon.
Homalota, undetermined species. Gallinas canyon.
2044 Tachyusa nigrella Lec. Santa Fe canyon.
2055 Aleochara bimaculata Grav. Santa Fe canyon, Gallinas canyon, Magdalena mountains.
2059 nitida Grav. Gallinas canyon.
Thiasophila, undetermined species. Gallinas canyon.
Gyrophæna, undetermined species. Walnut creek.
2096 Heterothops fumigatus Lec. Santa Fe canyon.
2096*b* californicus Lec. Gallinas canyon.
2098 Quedius explanatus Lec. Gallinas canyon, Santa Fe canyon, Magdalena mountains.
2099 spelæus Horn. Gallinas canyon.
2100 fulgidus Fab. Magdalena mountains.
2106 lævigatus Gyll. Magdalena mountains.
2107 molochinus Grav. Gallinas canyon.
2108 hyperboreus Er. Gallinas canyon.
2119 Creophilus villosus Grav. Gallinas canyon, Santa Fe canyon.
2132 Staphylinus mysticus Er. Walnut creek.
2136 fossator Grav. Gallinas canyon, Santa Fe canyon.
2137 comes Lec. Walnut creek.
2138 cinnamopterus Grav. Gallinas canyon.
2146 Belonuchus formosus Grav. Walnut creek.
2150 Philonthus furvus Nord. Santa Fe canyon, Gallinas canyon.
2170 flavolimbatus Er. Santa Fe canyon. Walnut creek.
2177 debilis Grav. Santa Fe canyon.
2178 varians Payk. Gallinas canyon.
2179 longicornis Steph. Santa Fe canyon.
2191 triangulum Horn. Santa Fe canyon.
2204 sordidus Grav. Water canyon.
2221 nigritulus Grav. Gallinas canyon.
2226 picicornis Horn. Gallinas canyon.
2230 quadrulus Horn. Walnut creek.
undetermined species. Walnut creek, Water canyon.
2301 Dianous nitidulus Lec. Santa Fe canyon.
Stenus, undetermined species. Gallinas canyon.

Family STAPHYLINIDÆ.

Lithocharis, new species. Walnut creek.
Conosoma, undetermined species. Walnut creek.
2670 Bryoporus rufescens Lec. Walnut creek.
2737 Bledius ornatus Lec. Santa Fe canyon, Albuquerque.
2747 Platystethus americanus Er. Santa Fe canyon, Gallinas canyon.
2753 Oxytelus fuscipennis Mann. Santa Fe canyon.
Trogophlœus, undetermined species. Socorro.
2801 Geodromicus ovipennis Lec. Santa Fe canyon, Gallinas canyon.
Deliphrum brevicolle.
Homalium, undetermined species. Magdalena mountains.
2911 Micropeplus tesserula Curt. Gallinas canyon.

Family TRICHOPTERYGIDÆ.

Trichopteryx, undetermined species. Gallinas canyon.

Family PHALACRIDÆ.

2992 Phalacrus penicillatus Say. Gallinas canyon.
2996 Olibrus vittatus Lec. Gallinas canyon, Walnut creek.
3007 nitidus Melsh. Walnut creek.
two undetermined species. Gallinas canyon.

Family COCCINELLIDÆ.

3037 Megilla vittigera Mann. Albuquerque.
3041 Hippodamia 5-signata Kirby. Water canyon.
3043 lecontei Muls. Gallinas canyon, Albuquerque.
3046 convergens Guer. Gallinas canyon, Santa Fe canyon, Water canyon, Magadalena mountains.
3048 oregonensis Cr. Walnut creek.
3049 sinuata Muls. Walnut creek.
3051 parenthesis Say. Gallinas canyon.
3058 Coccinella 9-notata Hbst. Gallinas canyon.
3059 transversoguttata Fab. Gallinas canyon, Santa Fe canyon.
3060 monticola Muls. Gallinas canyon.
3064 sanguinea Linn. Gallinas canyon, Santa Fe canyon.
3065*a* Olla abdominalis Say. Gallinas canyon, Water canyon.
3069 Harmonia picta Rand. Gallinas canyon.
Anatis lecontei Casey. Gallinas canyon, Magdalena mountains.
3077 subvittata Muls. Gallinas canyon, Santa Fe canyon.
3078 Psyllobora 20-maculata Say. Gallinas canyon.
3078*a* tædata Lec. Magdalena mountains.
3082 Exochomus pilatii Muls. Gallinas canyon.
3083*a* æthiops Bland. Gallinas canyon.
3094 Brachyacantha dentipes Fab. Magdalena mountains.
3095*a* 10-pustulata Melsh. Gallinas canyon.
3101 Hyperaspis fimbriolata Melsh. Gallinas canyon.
3148 Scymnus collaris Melsh. Gallinas canyon.
3155 marginicollis Mann. Socorro.
3173 Epilachna corrupta Muls. Gallinas canyon, Water canyon, Albuquerque.

Family ENDOMYCHIDÆ.

3183 Aphorista morosa Lec. Santa Fe canyon, Magdalena mountains.
Mycetina morosa Lec. Gallinas canyon.
3197 Epipocus unicolor Horn. Gallinas canyon.

Family EROTYLIDÆ.

3209 Languria gracilis Newm. Water canyon.
3240 Erotylus boisduvali Chev. Water canyon, Santa Fe canyon, Gallinas canyon, Magdalena mountains.

Family COLYDIIDÆ.

3288 Bothrideres montanus Horn. Santa Fe canyon, Magdalena mountains.

Family CUCUJIDÆ.

3314 Pediacus fuscus Er. Gallinas canyon.

Family CRYPTOPHAGIDÆ.

3363 Henoticus serratus Gyll. Gallinas canyon.
Atomaria, two undetermined species. Gallinas canyon.
Salebius, undetermined species. Gallinas canyon.

Family MYCETOPHAGIDÆ.

3397 Mycetophagus pluripunctatus Lec. Gallinas canyon.

Family DERMESTIDÆ.

3418 Dermestes marmoratus Say. Water canyon, Santa Fe canyon, Gallinas canyon, Albuquerque.
3420 caninus Germ. Water canyon.
3421 talpinus Mann. Gallinas canyon.
3428 vulpinus Fab. Water canyon, Santa Fe canyon.
3445 Anthrenus varius Fab. Gallinas canyon.
3448 Cryptorhopalum balteatum Lec. Gallinas canyon.
2450 apicale Mann. Gallinas canyon.
3455 Orphilus glabratus Fab. Gallinas canyon, Santa Fe canyon.

Family HISTERIDÆ.

3471 Hister instratus Lec. Gallinas canyon.
3472 biplagiatus Lec. Magdalena mountains.
3483 marginicollis Lec. Santa Fe canyon.
3490 abbreviatus Fab. Santa Fe canyon, Magdalena mountains, Socorro, Gallinas canyon.
3491 civilis Lec. Magdalena mountains.
3494 depurator Say. Gallinas canyon, Santa Fe canyon.
3539 Epierus nasutus Horn. Gallinas canyon.
3583 Saprinus lugens Er. Gallinas canyon.
3585 pennsylvanicus Payk. Water canyon.
3586 oregonensis Lec. Gallinas canyon, Santa Fe canyon, Socorro.
3605 neglectus Mars. Gallinas canyon, Water canyon.
3610 fimbriatus Lec. Gallinas canyon, Santa Fe canyon.
3641 Teretrius montanus Horn. Santa Fe canyon.

Family NITIDULIDÆ.

3673 Carpophilus pallipennis Say. Gallinas canyon, Santa Fe canyon.
3674 dimidiatus Fab. Gallinas canyon.
3697 Epuræa rufa Say. Gallinas canyon.
3699 ambigua Mann. Socorro.
3704 immunda Sturm. Gallinas canyon.
3709 truncatella Mann. Walnut creek.
3713 æstiva Linn. Gallinas canyon.
3721 Nitidula ziczac Say. Gallinas canyon, Santa Fe canyon, Magdalena mountains.
3721 ziczac, var. Gallinas canyon.
3730 Soronia undulata Say. Gallinas canyon.
3733 Perthalycra murrayi Horn. Gallinas canyon, Santa Fe canyon.
3736 Orthopeplus quadricollis Horn. Walnut creek.
3739 Meligethes mutatus Harr. Santa Fe canyon, Gallinas canyon.
3751 Cybocephalus californicus Horn. Walnut creek.
3761 Pityophagus cephalotes Lec. Water canyon.
3762 rufipennis Horn. Walnut creek.
3763 verticalis Horn. Gallinas canyon, Walnut creek.
3767 Rhizophagus dimidiatus Mann. Walnut creek.

Family LATRIDIIDÆ.

3796 Coninomus carinatus Gyll. Gallinas canyon.
3799 Corticaria dentigera Lec. Gallinas canyon.
3804 delecta Mann. Gallinas canyon.
two undetermined species. Gallinas canyon.

Family TROGOSITIDÆ.

3832 Alindria teres Melsh. Magdalena mountains.
3833 Trogosita virescens Fab. Magdalena mountains.
3838 Tenebrioides corticalis Melsh. Magdalena mountains, Santa Fe canyon, Gallinas canyon.
3843 castanea Melsh. Santa Fe canyon.
3848 Peltis pippingskœldi Mann. Santa Fe canyon.
3850 Calitys scabra Thunb. Magdalena mountains.

Family BYRRHIDÆ.

3890 Byrrhus cyclophorus Kirby. Walnut creek.
new species. Walnut creek.
3903 Limnichus analis Lec. Santa Fe canyon.

Family PARNIDÆ.

3923 Dryops striatus Lec. Santa Fe canyon, Magdalena mountains, Gallinas canyon.
3924 suturalis Lec. Gallinas canyon.
3926 Elmis concolor Lec. Santa Fe canyon.
3933 divergens Lec. Santa Fe canyon.

Family DASCYLLIDÆ.

3986 Ptilodactyla serricollis Say. Gallinas canyon.

Family RHIPICERIDÆ.

4024 Sandalus californicus Lec. Walnut creek.

Family ELATERIDÆ.

4030 Deltometopus amœnicornis Say. Gallinas canyon.
4064 Anelastes drurii Kirby. Gallinas canyon, Santa Fe canyon, Magdalena mountains.
4077 Adelocera rorulenta Lec. Gallinas canyon.
Chalcolepidius apacheanus Casey. Walnut creek.
4095 Alaus melanops Lec. Gallinas canyon.
4109 Cardiophorus gagates Er. Magdalena mountains.
4110 longior Lec. Santa Fe canyon.
4113 tenebrosus Lec. Magdalena mountains.
4150 Cryptohypnus bicolor Esch. Santa Fe canyon.
4161 pectoralis Say. Santa Fe canyon.
4188 Monocrepidius sordidus Lec. Albuquerque.
4197 Ischiodontus soleatus Say. Albuquerque.
4202 Elater rhodopus Lec. Magdalena mountains.
4204 rubriventris Lec. Gallinas canyon.
4218 nigrinus Payk. Walnut creek.
4220 pullus Germ. Walnut creek.
new species. Gallinas canyon.
4299 Glyphonyx recticollis Say. Water canyon.
4322 Melanotus fissilis Say. Gallinas canyon.
4324 exuberans Lec. Gallinas canyon.
4344 paradoxus Melsh. Walnut creek.
4400 Athous cribratus Lec. Santa Fe canyon, Gallinas canyon.
4465 Corymbites rupestris Germ. Santa Fe canyon, Magdalena mountains.
4486 æripennis Kirby. Walnut creek.
4496 inflatus Say. Gallinas canyon.
4502 Asaphes carbonatus Lec. Gallinas canyon, Albuquerque.
4510 memnonius Hbst. Gallinas canyon.

Family BUPRESTIDÆ.

4567 Halecia gentilis Horn. Walnut creek.
4568 Chalcophora angulicollis Lec. Gallinas canyon.
4575*a* Psiloptera webbii Lec. Water canyon.
4576 Dicerca prolongata Lec. Gallinas canyon.
sexualis Cr. Gallinas canyon.
4594 Pœcilonota cyanipes Say. Gallinas canyon.
4602 Buprestis consularis Gory. Gallinas canyon.
4604 nuttalli Kirby. Gallinas canyon, Water canyon.
4606 maculiventris Say. Gallinas canyon, Santa Fe canyon, Magdalena mountains.
4607*a* langii Mann. Gallinas canyon.
4610 lauta Lec. Gallinas canyon, Santa Fe canyon.
4611 adjecta Lec. Gallinas canyon.
4619 Melanophila longipes Say. Gallinas canyon.
4621 drummondi Kirby. Gallinas canyon, Santa Fe canyon, Magdalena mountains.
4621 drummondi, var. Magdalena mountains.
4623 gentilis Lec. Gallinas canyon.
4628 Anthaxia æneogaster Lap. Gallinas canyon.
4634 flavimana Gory. Gallinas canyon.

Family Buprestidæ.

4639 Chrysobothris femorata Fab. Magdalena mountains, Santa Fe canyon.
4644 4-lineata Lec. Magdalena mountains, Gallinas canyon, Water canyon.
4645 texana Lec. Walnut creek.
4647 dentipes Germ. Gallinas canyon.
4650 trinervia Kirby. Gallinas canyon, Santa Fe canyon.
4662 æneola Lec. Gallinas canyon.
4664 atrofasciata Lec. Walnut creek.
10070 axillaris Horn. Magdalena mountains.
4677 Acmæodera amplicollis Lec. Water canyon.
4679 amabilis Horn. Walnut creek.
4686 miliaris Horn. Walnut creek, Santa Fe canyon, Magdalena mountains.
4692 ornata Fab. Water canyon.
4695 decipiens Lec. Walnut creek.
4698 mima Gory. Walnut creek, Water canyon.
4699 pulchella Hbst. Santa Fe canyon, Magdalena mountains, Gallinas canyon.
4707 culta Web. Gallinas canyon.
4708 4-vittata Horn. Gallinas canyon.
4716 Chrysophana placida Lec. Gallinas canyon.
4724*b* Agrilus defectus Lec. Magdalena mountains.
4732 interruptus Lec. Gallinas canyon.
4742 politus Say. Gallinas canyon.
4746 egenus Gory. Gallinas canyon.
10126 blandus Horn. Socorro.
4761 Brachys ærosa Melsh. Gallinas canyon.
4764 Pachyscelus purpureus Say. Gallinas canyon.

Family Lampyridæ.

4767 Rhyncheros sanguinipennis Say. Gallinas canyon, Magdalena mountains.
4768 Lycus cruentus Lec. Walnut creek.
4769 fernandezii Duges. Walnut creek.
4771 Lycostomus fulvellus Lec. Gallinas canyon.
4772 loripes Chev. Walnut creek.
Cænia, undetermined species. Santa Fe canyon.
4781 amplicornis Lec. Gallinas canyon.
4787 Eros aurora Hbst. Gallinas canyon, Walnut creek.
4794 Plateros modestus Say. Gallinas canyon.
4795 canaliculatus Say, var. Gallinas canyon, Walnut creek.
4796 sollicitus Lec. Magdalena mountains.
4800 Lygistopterus rubripennis Lec. Gallinas canyon.
4806 Calochromus ruficollis Lec. Gallinas canyon, Santa Fe canyon, Magdalena mountains.
4813 Ellychnia flavicollis Lec. Gallinas canyon.
4814 californica Mots. Gallinas canyon.
4815 corrusca Linn. Gallinas canyon, Santa Fe canyon.
4820 Pyropyga decipiens Harr. Water canyon.
4870 Chauliognathus limbicollis Lec. Gallinas canyon.

Family LAMPYRIDÆ.

4872 Chauliognathus scutellaris Lec. Gallinas canyon, Santa Fe canyon, Water canyon.
4873 lewisii Cr. Water canon.
4901 Podabrus piniphilus Esch. Gallinas canyon.
4902 lateralis Lec. Walnut creek.
4926 Telephorus dentiger Lec. Gallinas canyon.
4939 flavipes Lec. Gallinas canyon.
4953 tuberculatus Lec. Gallinas canyon.

Family MALACHIDÆ.

4995 Collops punctatus Lec. Water canyon.
4996 eximius Er. Gallinas canyon.
5002 bipunctatus Say. Gallinas canyon, Water canyon, Santa Fe canyon, Magdalena mountains.
5004 4-maculatus Fab., var. Santa Fe canyon.
5013 vittatus Say. Albuquerque.
5017 Trophimus æneipennis Horn. Gallinas canyon.
5051 Attalus basalis Lec. Gallinas canyon.
5055 morulus Lec. Santa Fe canyon.
5066 difficilis Lec. Gallinas canyon.
5099 Pristoscelis rufipennis Lec. Water canyon.
5100 comatus Lec. Gallinas canyon, Santa Fe canyon, Magdalena mountains.
5109 Listrus senilis Lec. Gallinas canyon, Magdalena mountains.
5117 Dasytes hudsonicus Lec. Magdalena mountains.

Family CLERIDÆ.

5131 Cymatodera puncticollis Bland. Walnut creek.
5134 cylindricollis Chev. Walnut creek, Albuquerque.
5155 Aulicus nero Spin. Water canyon.
5158 Trichodes ornatus Say. Gallinas canyon.
5158*a* tenellus Lec. Gallinas canyon.
5161 apivorus Germ. Santa Fe canyon, Albuquerque.
5164 Clerus spinolæ Lec. Walnut Creek.
5166 analis Lec. Water canyon.
5175 cordifer Lec. Gallinas canyon.
5177 nigriventris Lec. Gallinas canyon.
5178 sphegeus Fab. Gallinas canyon.
5179 mœstus Kl. Gallinas canyon, Magdalena mountains.
atriventris Lec. Gallinas canyon.
new species. Santa Fe canyon.
5185 Thanasimus undulatus Say. Gallinas canyon.
5189 Hydnocera unifasciata Say. Magdalena mountains.
5191 subfasciata Lec. Magdalena mountans.
5192 subænea Spin. Magdalena mountains, Gallinas canyon.
5195 pubescens Lec. Magdalena mountains, Gallinas canyon.
5197 discoidea Lec. Walnut creek.
5228 Lebasiella discoidea Lec. Santa Fe canyon.
5230 Necrobia rufipes Fab. Santa Fe canyon, Water canyon, Magdalena mountains.
5232 violaceus Linn. Gallinas canyon.

Family PTINIDÆ.

5244 Ptinus interruptus Lec. Santa Fe canyon.
Ernobius, new species. Gallinas canyon, Walnut creek.
5281 Trypopitys sericeus Say. Walnut creek.
5304 Catorama sectans Lec. Magdalena mountains.
5332 Ptilinus ruficornis Say. Walnut creek.
5334 thoracicus Rand. Magdalena mountains.

Family LUCANIDÆ.

5413 Lucanus mazama Lec. Gallinas canyon, Santa Fe canyon.
5414 placidus Say. Gallinas canyon.
5419 Platycerus depressus Lec. Santa Fe canyon.

Family SCARABÆIDÆ.

5428 Canthon praticola Lec. Santa Fe canyon, Water canyon.
5435 lævis Drury. Gallinas canyon.
5446 Copris mœchus Lec. Walnut creek.
5450 Phanæus quadridens Say. Walnut creek.
5452 carnifex Linn. Gallinas canyon, Water canyon, Socorro.
5457 Onthophagus coproides Horn. Santa Fe canyon, Water canyon.
5458 hecate Panz. Santa Fe canyon, Gallinas canyon.
5484 Rhyssemus cælatus Lec. Santa Fe canyon.
5488 Atœnius robustus Horn. Magdalena mountains.
5490 figurator Harr. Water canyon.
5491 gracilis Melsh. Albuquerque.
5499 abditus Hald. Albuquerque.
5511 Aphodius hyperboreus Lec. Santa Fe canyon.
5513 occidentalis Horn. Magdalena mountains.
5521 crassulus Horn. Santa Fe canyon.
5522 ursinus Mots. Santa Fe canyon, Gallinas canyon.
5523 ruricola Melsh. Sante Fe canyon, Water canyon.
5529 vittatus Say. Santa Fe canyon, Magdalena mountains.
5550 consentaneus Lec. Walnut creek.
5555 cruentatus Lec. Gallinas canyon.
5556 subtruncatus Lec. Gallinas canyon.
5564 coloradensis Horn. Gallinas canyon, Water canyon.
duplicatus. Santa Fe canyon, Water canyon.
undetermined species. Walnut creek.
5580 Ochodœus ulkei Horn. Gallinas canyon.
5582 frontalis Lec. Walnut creek.
5583 striatus Lec. Walnut creek.
5590 Bolboceras farctus Fab. Water canyon.
5591 lazarus Fab. Water canyon, Gallinas canyon, Albuquerque.
5612 Trox scutellaris Say. Water canyon, Albuquerque.
5616 suberosus Fab. Water canyon.
5617 puncatus Germ. Water canyon.
5618 tuberculatus De G. Magdalena mountains.
5620 sonoræ Lec. Santa Fe canyon, Gallinas canyon, Water canyon.
5630 atrox Lec. Santa Fe canyon.
5648 Hoplia laticollis Lec. Gallinas canyon.

Family SCARABÆIDÆ.

5669 Dichelonycha sulcata Lec. Gallinas canyon.
5674 Serica vespertina Gyll. Gallinas canyon.
5677 serotina Lec. Walnut creek.
5682 curvata Lec. Walnut creek, Gallinas canyon, Magdalena mountains.
5684 mixta Lec. Gallinas canyon.
new species. Gallinas canyon.
5692 Macrodactylus uniformis Horn. Gallinas canyon, Water canyon.
5704 Diplotaxis brevicollis Lec. Santa Fe, Gallinas canyon, Water canyon.
5705 obscura Lec. Magdalena mountains, Water canyon.
5721 carbonata Lec. Albuquerque, Water canyon.
5733 haydenii Lec. Gallinas canyon.
undetermined species. Walnut creek.
5739 Lachnosterna lanceolata Say. Gallinas canyon, Water canyon.
5757 fusca Froh. Gallinas canyon.
5761 micans Knoch. Gallinas canyon.
5775 affinis Lec. Gallinas canyon.
5781 hirsuta Knoch. Gallinas canyon.
10261 vetula Horn. Gallinas canyon.
undetermined species. Gallinas canyon.
new species, near ephelida Horn. Walnut creek.
longipilis Horn. Walnut creek.
Phytalus, new species. Walnut creek.
5804 debilis Horn. Walnut creek.
5806 Listrochelus disparilis Horn. Gallinas canyon.
5817 falsus Lec. Gallinas canyon, Santa Fe canyon.
5818 fimbripes Lec. Magdalena mountains.
5820 Polyphylla hammondi Lec. Albuquerque.
5820 hammondi Lec., var. Albuquerque.
5822 decemlineata Say. Albuquerque, Gallinas canyon.
5823 crinita Lec. Walnut creek.
5842 Strigoderma arboricola Fab. Walnut creek.
5847 Plusiotis gloriosa Lec. Walnut creek, Water canyon.
5848 lecontei Horn. Walnut creek, Water canyon.
5858 Cyclocephala immaculata Oliv. Water canyon.
5866 manca Lec. Walnut creek.
5869 Ligyrus gibbosus De G. Albuquerque, Water canyon.
5873 Aphonus pyriformis Lec. Gallinas canyon.
5874 tridentatus Say. Santa Fe canyon.
5877 clunalis Lec. Santa Fe canyon.
5878 Orizabus snowi Horn. Albuquerque, Walnut creek.
5880 Xyloryctes satyrus Fab. Walnut creek.
5885 Strategus cessus Lec. Albuquerque, Walnut creek, Water canyon.
5887 Dynastes grantii Horn. Silver City.
5893 Allorhina mutabilis Gory. Socorro.
5894 nitida Linn. Water canyon.
5896 Gymnetis cretacea Lec. Walnut creek.
5901 Euphoria kernii Hald. Gallinas canyon, Water canyon.
5909 fulgida Fab. Gallinas canyon.

Family SCARABÆIDÆ.

5911 Euphoria inda Linn. Gallinas canyon, Water canyon, Santa Fe canyon, Magdalena mountains.
undetermined species. Walnut creek.
5924 Cremastochilus crinitus Lec. Magdalena mountains.
5925 knochii Lec. Santa Fe canyon.
5939 Trichius affinis Gory. Gallinas canyon.

Family SPONDYLIDÆ.

5948 Spondylis uniformis Mann. Walnut creek.

Family CERAMBYCIDÆ.

5950 Ergates spiculatus Lec. Magdalena mountains, Gallinas canyon.
5957 Derobrachus brevicollis Serv. Water canyon.
5961 Prionus californicus Mots. Water canyon, Gallinas canyon.
5966 Homæsthesis emarginatus Say. Gallinas canyon.
5967 Tragosoma harrisii Lec. Gallinas canyon.
5973 Nothorhina aspera Lec. Gallinas canyon.
5974 Criocephalus productus Lec. Santa Fe canyon, Gallinas canyon, Magdalena mountains.
5976 asperatus Lec. Gallinas canyon.
5981 Tetropium velutinum Lec. Gallinas canyon.
5982 cinnamopterum Kirby. Gallinas canyon.
5992 Hylotrupes ligneus Fab. Walnut creek.
6002 Phymatodes dimidiatus Kirby. Gallinas canyon.
6008 Callidium antennatum Newm. Walnut creek.
6012 hirtellum Lec. Gallinas canyon.
6049 Romaleum simplicicolle Hald. Walnut creek.
6105 Rhopalophora longipes Say. Santa Fe canyon, Gallinas canyon.
6105 longipes Say., var. Santa Fe canyon, Gallinas canyon.
Pteroplatus, new species. Gallinas canyon.
6119 Dendrobias quadrimaculatus Dup. Walnut creek.
6122 Stenaspis solitaria Say. Deming.
6126 Tragidion annulatum Lec. Magdalena mountains, Gallinas canyon.
6127*a* fulvipenne Say. Magdalena mountains, Gallinas canyon, Santa Fe canyon, Water canyon.
6140 Batyle ignicollis Say. Gallinas canyon, Water canyon.
6141 pearsalli Bland., var. Gallinas canyon.
6147 Tylosis maculata Lec. Gallinas canyon, Albuquerque.
6152 Crossidius intermedius Ulke. Socorro.
6153 pulchellus Lec. Gallinas canyon, Water canyon.
6157 discoideus Say. Gallinas canyon, Socorro.
6158 Sphænothecus suturalis Lec. Deming.
Stenosphenus, undetermined species. Magdalena mountains, Walnut creek.
6172 Cyllene infaustus Lec., var. Gallinas canyon.
6172 lutosus Lec., var. Gallinas canyon, Magdalena mountains.
6174 Calloides nobilis Say. Gallinas canyon.
6180 Xylotrechus sagittatus Germ. Gallinas canyon.
6183 undulatus Say. Gallinas canyon, Magdalena mountains, Santa Fe canyon.
6183 undulatus Say., var. Santa Fe canyon.

Family CERAMBYCIDÆ.

6232 Rhagium lineatum Oliv. Gallinas canyon.
6248 Pachyta liturata Kirby. Gallinas canyon.
6267 Acmæops longicornis Kirby. Gallinas canyon.
6274 pratensis Laich. Gallinas canyon.
6286 Strangalia sexnotata Hald. Gallinas canyon.
6289 Typocerus zebratus Fab. Gallinas canyon.
6292 velutinus Oliv. Gallinas canyon.
6294 brunnicornis Lec. Gallinas canyon.
6296 sinuatus Newm. Gallinas canyon.
6330 Leptura nigrella Say, var. Gallinas canyon.
6331 carbonata Lec. Gallinas canyon.
6332*b* cribripennis Lec. Gallinas canyon, Santa Fe canyon.
6337 sanguinea Lec. Gallinas canyon.
6341 chrysocoma Kirby. Gallinas canyon.
6342 nigrolineata Bland. Gallinas canyon, Walnut creek.
6361 mutabilis Newm. Gallinas canyon.
6369 Monilema annulatum Say. Gallinas canyon.
6370 appressum Lec. Magdalena mountains.
6373 lævigatum Bland. Santa Fe canyon.
6381 crassum Lec. Gallinas canyon.
6386 Monohammus maculosus Hald. Gallinas canyon, Santa Fe canyon.
6387 scutellatus Say. Gallinas canyon.
6418 Leptostylus biustus Lec. Walnut creek.
undetermined species. Walnut creek.
6433 Dectes spinosus Say. Gallinas canyon.
6441 Hyperplatys maculatus Hald. Gallinas canyon.
6446 Acanthocinus obliquus Lec. Gallinas canyon, Santa Fe canyon.
6447 spectabilis Lec. Gallinas canyon, Santa Fe canyon.
6453 Pogonocherus mixtus Hald. Gallinas canyon, Santa Fe canyon, Magdalena mountains.
6478 Saperda calcarata Say. Gallinas canyon.
6492 Mecas pergrata Say. Gallinas canyon.
6509 Tetraopes discoideus Lec. Gallinas canyon.
6513 femoratus Lec. Gallinas canyon.
6513*b* basalis Lec. Gallinas canyon.
6515 canescens Lec. Gallinas canyon.

Family CHRYSOMELIDÆ.

10331 Aulacoscelis purpurea Horn. Magdalena mountains.
undetermined species. Walnut creek.
6550 Orsodachna atra Ahr., var. childreni Kirby. Gallinas canyon.
6550 var. trivittata Lec. Walnut creek.
6550 unnamed variety. Gallinas canyon.
6552 Zeugophora abnormis Lec. Gallinas canyon, Magdalena mountains.
6556 consanguinea Cr. Gallinas canyon.
6558 Syneta carinata Mann. Gallinas canyon.
6563 Lema concolor Lec. Gallinas canyon.
6573 trilineata Oliv. Gallinas canyon.
6573 trilineata Oliv., var. trivirgata Lec. Gallinas canyon.
new species. Gallinas canyon.

Family CHRYSOMELIDÆ.

6579 Anomœa laticlavia Forst. Gallinas canyon.
6587 Coscinoptera axillaris Lec. Magdalena mountains.
6592 vittigera Lec., var. arizonensis.
6596 Babia 4-guttata Oliv. Gallinas canyon.
6596*b* 4-guttata Oliv., var. tetraspilota Lec. Magdalena mountains, Walnut creek.
6598 Saxinis omogera Lec. Gallinas canyon.
6600 Urodera crucifera Lec. Gallinas canyon, Magdalena mountains.
6605 Exema conspersa Mann. Socorro, Walnut creek.
6617*a* Cryptocephalus quadriplex Newm., var. 4-guttulus Suffr. Gallinas canyon.
6624 amatus Hald. Walnut creek.
6626 confluens Say. Socorro, Magdalena mountains.
new species. Magdalena mountains.
6653? Pachybrachys xanti Cr. Walnut creek.
6655 morosus Hald. Gallinas canyon.
6659 litigiosus Suffr. Gallinas canyon.
6660 abdominalis Say., var. Walnut creek.
6661 dubiosus Lec. Gallinas canyon.
6673 tridens Melsh. Gallinas canyon.
6687 subvittatus Lec. Gallinas canyon.
6690 atomarius Melsh. Gallinas canyon, Magdalena mountains.
6697 hepaticus Melsh. Gallinas canyon.
undetermined species. Magdalena mountains.
two new species. Gallinas canyon.
6707 Diachus auratus Fab. Gallinas canyon, Walnut creek.
6720 Xanthonia 10-notata Say. Gallinas canyon, Santa Fe canyon.
Heteraspis marcassita Germ. Santa Fe canyon.
6741 Chrysochus auratus Fab. Gallinas canyon.
6748 Paria atterima Oliv. Gallinas canyon.
6769 Graphops marcassita Cr. Santa Fe canyon.
undetermined species. Magdalena mountains.
6789 Doryphora 10-lineata Say. Magdalena mountains.
new species. Gallinas canyon.
6794 rubiginosa Rog. Water canyon.
6795 Chrysomela exclamationis Fab. Gallinas canyon.
6796 conjuncta Rog. Gallinas canyon.
6798 continua Lec. Gallinas canyon.
6799 suturalis Fab. Gallinas canyon.
6810 multipunctata Say. Gallinas canyon.
6813 tortuosa Rog. Walnut creek.
6815 serpentina Rog. Walnut creek.
6816 multiguttata Stal. Walnut creek.
6821 auripennis Say. Gallinas canyon.
new species. Gallinas canyon.
6828 Plagiodera viridis Melsh. Gallinas canyon, Water canyon.
6836 Lina arizonæ Cr. Walnut creek.
6837 lapponica Linn. Magdalena mountains.
6839 scripta Fab. Magdalena mountains.

Family CHRYSOMELIDÆ.

6861 Luperus varicornis Lec. Walnut creek.
6867 lecontei Cr. Gallinas canyon.
6869 longulus Lec. Gallinas canyon.
6879 Diabrotica tricincta Say. Socorro.
6881 12-punctata Oliv. Socorro.
6881*a* tenella Lec. Magdalena mountains.
6884 blandula Lec. Gallinas canyon.
6888 longicornis Say. Socorro.
6889 lemniscata Lec. Socorro.
6891 atripennis Say. Gallinas canyon.
6892*b* Trirhabda canadensis Kirby. Gallinas canyon.
6895 convergens Lec. Walnut creek.
6898 Adimonia externa Say. Gallinas canyon.
6899 americana Fab. Gallinas canyon.
6899*a* cribrata Lec. Gallinas canyon.
6904 Galeruca tuberculata Say. Gallinas canyon.
6916 Monoxia guttulata Lec. Santa Fe canyon, Gallinas canyon.
10407 debilis Lec. Magdalena mountains.
puncticollis Say. Albuquerque.
6933 Œdionychis lugens Lec. Gallinas canyon.
6942 texana Cr. Gallinas canyon.
6948 Disonycha alternata Ill. Socorro, Gallinas canyon.
6949 punctigera Lec. Walnut creek.
6954 abbreviata Melsh. Gallinas canyon.
10419 politula Horn. Gallinas canyon.
6957 triangularis Say. Gallinas canyon.
6958 xanthomelæna Dalm. Gallinas canyon.
6958*c* semicarbonata Lec. Magdalena mountains.
10416 crenicollis Say. Albuquerque.
6960 Haltica bimarginata Say. Albuquerque, Santa Fe canyon.
6962 carinata Germ. Gallinas canyon, Socorro.
6972 punctipennis Lec. Gallinas canyon, Magdalena mountains.
6973 lazulina Lec. Albuquerque.
undetermined species. Socorro.
three undetermined species. Gallinas canyon.
6987 Crepidodera cucumeris Harr. Gallinas canyon, Magdalena mountains.
6991 parvula Fab. Soccoro.
7002 Systena marginalis Ill. Gallinas canyon.
7002 marginalis, var. oblonga Lec. Gallinas canyon.
7003 blanda Melsh. Magdalena mountains, Gallinas canyon.
Longitarsus vanus Horn. Magdalena mountains.
three undetermined species. Gallinas canyon.
7016 Glyptina spuria Lec. Gallinas canyon.
atriventris Horn. Socorro.
new species. Gallinas canyon.
7027 Phyllotreta albionica Lec. Gallinas canyon.
10458 pusilla Horn. Socorro.
7040 Chætocnema denticulata Ill. Santa Fe canyon.
7046 subviridis Lec. Gallinas canyon.
7049 crenulata Cr. Gallinas canyon.

Family CHRYSOMELIDÆ.

7058 Psylliodes punctulata Melsh. Socorro.
7060 Microrhopala vittata Fab. Albuquerque.
7064 vulnerata Horn. Walnut creek.
7073 Odontota collaris Say. Walnut creek.
7074 omogera Cr. Walnut creek.
7077 bicolor Oliv. Gallinas canyon.
7082 nervosa Panz. Gallinas canyon.
7086 Charistena perspicua Horn. Walnut creek.
new species. Walnut creek.
7091 Octotoma marginicollis Horn. Walnut creek.
7097 Cassida nigripes Oliv. Gallinas canyon.
7102 Coptocycla aurichalcea Fab. Gallinas canyon.

Family BRUCHIDÆ.

7135 Bruchus aureolus Horn. Gallinas canyon.
7137 prosopis Lec. Socorro.

Family TENEBRIONIDÆ.

7167 Edrotes rotundus Say. Magdalena mountains.
7196 Emmenastus acutus Horn. Magdalena mountains, Gallinas canyon.
7199 obtusus Lec. Gallinas canyon.
undetermined species. Socorro.
7203 Epitragus canaliculatus Say. Santa Fe canyon.
7217 Zopherus concolor Lec. Gallinas canyon.
Eurymetopon new species. Gallinas canyon.
7229 Araeoschizus costipennis Lec. Magdalena mountains.
7250 Microschatia morata Horn. Gallinas canyon.
7253 Astrotus regularis Horn. Water canyon.
7254 Asida opaca Say. Gallinas canyon, Water canyon, Santa Fe canyon, Socorro, Magdalena mountains.
7257 polita Say. Gallinas canyon, Water canyon.
7259 sordida Lec. Gallinas canyon, Water canyon.
7261 morbillosa Lec. Water canyon.
blapsoides Sol. Magdalena mountains, Water canyon.
7281 convexa Lec. Water canyon.
7283 convexicollis Lec. Water canyon.
7284 marginata Lec. Water canyon, Santa Fe canyon.
7284*a* rimata Lec. Deming, Water canyon.
7286 elata Lec. Water canyon.
7287 macra Horn. Walnut creek.
new species. Water canyon.
7298 Coniontis ovalis Esch. Magdalena mountains.
7307 Eusattas reticulatus Say. Water canyon.
7315 muricatus Lec. Walnut creek.
7316 Eleodes obscura Say. Gallinas canyon, Water canyon.
7316*a* dispersa Lec. Gallinas canyon, Water canyon, Santa Fe canyon, Magdalena mountains.
7318 suturalis Say. Albuquerque, Water canyon.
7318*a* texana Lec. Gallinas canyon.
7320 tricostata Say. Gallinas canyon.
7322 carbonaria Say. Magdalena mountains, Water canyon.

Family TENEBRIONIDÆ.

7322 carbonaria Say, form debilis. Water canyon.
7322 carbonaria Say, form soror. Water canyon.
7323 obsoleta Say. Gallinas canyon. Water canyon.
7324 quadricollis Esch. Santa Fe canyon.
7327 extricata Say. Santa Fe canyon, Water canyon, Gallinas canyon.
7331 longicollis Lec. Water canyon, Socorro, Magadelena mountains.
7333 vertricosa Lec. Water canyon.
7335 gracilis Lec. Water canyon, Magdalena mountains.
7339 nigrina Lec. Santa Fe canyon, Magdalena mountains.
7340 hispilabris Say. Gallinas canyon.
7341 sponsa Lec. Gallinas canyon, Albuquerque, Socorro.
7342 caudifera Lec. Magdalena mountains, Water canyon.
7351 consobrina Lec. Magdalena mountains, Santa Fe canyon.
7353 planipennis Lec. Magdalena mountains, Santa Fe canyon, Water canyon.
7355 cordata Esch. Gallinas canyon.
7365 Embaphion contusum Lec. Santa Fe canyon.
7380 Argoporis bicolor Lec. Magdalena mountains.
7394 Iphthimus serratus Mann. Santa Fe canyon, Gallinas canyon.
7394 serratus Mann, var. Walnut creek.
7420 Bius estriatus Lec. Walnut creek.
7438 Blapstinus pratensis Lec. Santa Fe canyon, Gallinas canyon.
7442 mœstus Melsh. Magdalena mountains.
7457 Ulus crassus Lec. Water canyon.
undetermined species. Water canyon.
10617 Tribolium confusum Duv. Socorro.
7519 Platydema oregonense Lec. Gallinas canyon.
undetermined species. Santa Fe canyon.
7532 Hypophlœus parallelus Melsh. Gallinas canyon.
7564 Helops convexulus Lec. Gallinas canyon.
7568 arizonensis Horn. Walnut creek.

Family CISTELIDÆ.

Allecula, two undetermined species. Walnut creek.
new species. Gallinas canyon.
7592 Hymenorus obscurus Say. Santa Fe canyon.
undetermined species. Magdalena mountains.
undetermined species. Albuquerque.
7603 Cistela pinguis Lec. Gallinas canyon.
7622 Mycetochares lugubris Lec. Santa Fe canyon.

Family OTHNIIDÆ.

7633 Othnius umbrosus Lec. Santa Fe canyon.

Family LAGRIIDÆ.

Statira, new species, near resplendens Lec. Gallinas canyon.

Family MONOMMIDÆ.

7644 Hyporhagus opuntiæ Horn. Magdalena mountains.

Family MELANDRYIDÆ.

7648 Tetratoma concolor Lec. Gallinas canyon.
7659 Zilora hispida Lec. Santa Fe canyon.
7661 Carebara longula Lec. Gallinas canyon.
7666 Serropalpus barbatus Schall. Santa Fe canyon.
7677 Eustrophus indistinctus Lec. Walnut creek.
7684 Hallomenus punctulatus Lec. Santa Fe canyon.
7701 Lacconotus pinicolus Horn. Gallinas canyon.
7704 Myceterus concolor Lec. Gallinas canyon.
new species. Gallinas canyon.

Family PYTHIDÆ.

7707 Crymodes discicollis Lec. Gallinas canyon.
7717 Salpingus virescens Dec. Gallinas canyon.

Family ŒDEMERIDÆ.

7730 Ditylus obscurus Lec. Gallinas canyon.
undetermined species. Santa Fe canyon.
7740 Oxacis pallida Lec. Albuquerque.
undetermined species. Albuquerque.

Family MORDELLIDÆ.

7761 Pentaria trifasciata Melsh. Socorro.
7762 fuscula Lec. Magdalena mountains.
7765 Anaspis nigra Hald. Santa Fe canyon.
7766 atra Lec. Gallinas canyon.
7770 rufa Say. Gallinas canyon, Magdalena mountains.
7771 pusio Lec. Gallinas canyon.
7780 Mordella scutellaris Fab. Gallinas canyon.
7788 insulata Lec. Gallinas canyon.
7816 Mordellistena comata Lec. Magdelena mountains.
7833 nigricans Melsh. Magdelena mountains.
7863 angusta Lec. Santa Fe canyon.

Family ANTHICIDÆ.

7911 Xylophilus piceus Lec. Gallinas canyon.
7919 Notoxus bifasciatus Lec. Walnut creek.
new species. Gallinas canyon.
7945 Anthicus floralis Linn. Santa Fe canyon.

Family MELOIDÆ.

7999 Cysteodemus wislizeni Lec. Albuquerque, Socorro.
8000 Megetra vittata Lec. Socorro.
8015 Meloe sublævis Lec. Gallinas canyon, Socorro.
undetermined species, near rugipennis, Lec. Santa Fe canyoh.
8024 Nemognatha lurida Lec. Santa Fe canyon.
8024 lurida Lec., var. Santa Fe canyon.
8025 apicalis Lec. Walnut creek.
8026 lutea Lec. Gallinas canyon.
8027 bicolor Lec. Gallinas canyon, Santa Fe canyon.
8033 nigripennis Lec. Gallinas canyon.
8035 cribraria Lec. Gallinas canyon, Santa Fe canyon.

Family MELOIDÆ.

8037 Nemognatha immaculata Say. Gallinas canyon, Santa Fe canyon, Albuquerque.
8038 punctipennis Lec. Walnut creek.
8039 sparsa Lec. Albuquerque, Socorro.
8041 cribricollis Lec. Socorro, Gallinas canyon.
8042 Gnathium francilloni Kirby. Walnut creek.
8046 nitidium Horn. Walnut creek.
8047 Zonitis atripennis Say. Albuquerque, Santa Fe canyon.
8048 flavida Lec. Albuquerque, Santa Fe canyon.
8049 bilineata Say. Gallinas canyon.
8051 rufa Lec. Gallinas canyon.
8056 Macrobasis longicollis Lec. Walnut creek.
8057 atrivittata Lec. Albuquerque.
8061 unicolor Kirby. Gallinas canyon.
8064 ochrea Lec. Walnut creek.
8072 Tetraonyx fulva Lec. Gallinas canyon.
8074 Pleuropompha costata Lec. Deming, Albuquerque.
8082 Epicauta ferruginea Say. Gallinas canyon, Socorro.
8083 sericans Lec. Gallinas canyon.
8091 pardalis Lec. Gallinas canyon.
8103 corvina Lec. Socorro, Magdalena mountains.
8104 pennsylvanica De G. Albuquerque, Gallinas canyon.
8107 Pyrota mylabrina Chev. Socorro.
8117 lineata Oliv. Albuquerque.
8126 Cantharis mutilata Horn. Socorro.
8130 deserticola Horn. Walnut creek.
8131*a* cooperi Lec. Walnut creek.
8132 nuttalli Say. Gallinas canyon.
8139 biguttata Lec. Socorro, Gallinas canyon, Albuquerque.
new species. Walnut creek.
8169 Eupompha fissiceps Lec. Socorro.

Family RHIPIPHORIDÆ.

8177 Rhipiphorus pectinatus Fal. Gallinas canyon.
8183 Myodites scaber Lec. Socorro.

Family RHYNCHITIDÆ.

8210 Rhynchites bicolor Fab. Gallinas canyon.
8211 æneus Boh. Gallinas canyon.
8222 æratus Say. Magdalena mountains.

Family OTIORHYNCHIDÆ.

8233 Epicærus imbricatus Say. Walnut creek.
8242 Ophryastes vittatus Say. Gallinas canyon.
8245 sulcirostris Say. Gallinas canyon.
Eupagoderes, undetermined species, Magdalena mauntains.
8249 sordidus Lec. Magdalena mountains.
8258 Anametis grisea Horn. Gallinas canyon.
8262 Orimodema protracta Horn. Magdalena mountains.
8266 Peritaxia rugicollis Horn. Magdalena mountains, Santa Fe canyon, Gallinas canyon.

Family OTIORHYNCHIDÆ.

Amnesia, undetermined species. Magdalena mountains.
8294 Thricolepis inornata Horn. Magdalena mountains, Gallinas canyon.
8311 Tanymecus lacæna Hbst. Walnut creek.
8314 Pandeletejus hilaris Hbst. Santa Fe canyon, Gallinas canyon.
8317 Cyphus lautus Lec. Deming.
8323 Phacepholis elegans Horn. Gallinas canyon.
8325 candida Horn. Gallinas canyon, Walnut creek.

Family CURCULIONIDÆ.

8348 Sitones tibialis Hbst. Gallinas canyon.
Acmægenius, undetermined species. Walnut creek.
8360 Lepidophorus lineaticollis Kirby. Gallinas canyon.
Apion, undetermined species. Gallinas canyon.
undetermined species. Magdalena mountains.
undetermined species. Albuquerque.
8429 Phytonomus setigerus Lec. Gallinas canyon.
8515 Cleonopsis pulvereus Lec. Walnut creek.
8520 Cleonus frontalis Lec. Gallinas canyon, Santa Fe canyon.
8522 quadrilineatus Chev. Walnut creek.
8524 puberulus Lec. Walnut creek.
8526 vittatus Kirby. Gallinas canyon, Magdalena mountains.
8532 Dorytomus brevicollis Lec. Santa Fe canyon.
undetermined species. Gallinas canyon.
8544 Procas lecontei Bedel. Walnut creek.
8546 Desmoris constrictus Say. Albuquerque, Gallinas canyon.
8558 Smicronyx fulvus Lec. Albuquerque, Gallinas canyon.
10927 instabilis Casey. Socorro, Magdalena mountains.
8603 Otidocephalus vittatus Horn. Walnut creek.
8612 Magdalis cuneiformis Horn. Gallinas canyon, Santa Fe canyon.
8613 lecontei Horn. Gallinas canyon.
8630 Anthonomus quadrigibbus Say. Walnut creek.
8642 rufipennis Lec. Gallinas canyon.
8652 squamosus Lec. Gallinas canyon.
8654 hirtus Lec. Magdalena mountains.
8677 Orchestes niger Horn. Gallinas canyon.
8711 Læmosaccus plagiatus Fab. Gallinas canyon, Magdalena mountains.
8742 Rhyssematus lineaticollis Say. Gallinas canyon, Socorro.
8761 Acalles turbidus Lec. Gallinas canyon.
Cryptorhynchus, undetermined species. Walnut creek.
8804 Zascelis irrorata Lec. Walnut creek, Gallinas canyon.
8811 Copturus operculatus Say. Gallinas canyon.
8846 Ceutorhynchus squamatus Lec. Socorro.
undetermined species. Magdalena mountains, Socorro.
undetermined species. Magdalena mountains.
8866 Orthoris crotchii Lec. Gallinas canyon.
8868 Baris strenua Lec. Gallinas canyon.
undetermined species. Walnut creek.
8872 transversa Say. Magdalena mountains.
Pseudobaris, undetermined species. Walnut creek.
8899 Onychobaris cribrata Lec. Gallinas canyon.

Family CURCULIONIDÆ.

8926 Centrinus neglectus Lec. Gallinas canyon.
8928 picumnus Hbst. Gallinas canyon.
8960 Balaninus uniformis Lec. Santa Fe canyon.
8961 nasicus Say. Water canyon.

Family CALANDRIDÆ.

8973 Scyphophorus acupunctatus Gyll. Magdalena mountains.
8979 Rhodobænus pustulosus Gyll. Walnut creek.
8982 Sphenophorus ulkei Horn. Santa Fe canyon.
9014 Yuccaborus frontalis Lec. Magdalena mountains.
9024 Cossonus subareatus Boh. Magdalena mountains.
9026 concinnus Boh. Gallinas canyon, Santa Fe canyon.
9044 Rhyncholus brunneus Mann. Magdalena mountains, Santa Fe canyon.
undetermined species. Santa Fe canyon.

Family SCOLYTIDÆ.

Platypus, new species. Santa Fe canyon.
9059 Pityophthorus retusus Lec. Gallinas canyon, Socorro.
9079 puncticollis Lec. Gallinas canyon, Walnut creek.
new species. Walnut creek.
9093 Xyloterus bivittatus Kirby. Gallinas canyon.
9094 scabricollis Lec. Gallinas canyon.
9110 Xyleborus xylographus Say. Walnut creek.
9125 Tomicus plastographus Lec. Walnut creek, Magdalena mountains.
9127 rectus Lec. Walnut creek.
9147 Scolytus californicus Lec. Santa Fe canyon, Gallinas canyon.
9149 præceps Lec. Socorro.
9157 Polygraphus rufipennis Kirby. Walnut creek.
9179 Dendroctonus terebrans Oliv. Santa Fe canyon, Gallinas canyon.
9180 similis Lec. Walnut creek, Gallinas canyon.
9183 simplex Lec. Walnut creek, Gallinas canyon.
9190 Hylastes longus Lec. Gallinas canyon.
9194 gracilis Lec. Santa Fe canyon.
new species, near tenuis. Gallinas canyon.
9200 Hylurgops rugipennis Mann. Santa Fe canyon, Gallinas canyon.
undetermined species. Water canyon, Gallinas canyon.

Family ANTHRIBIDÆ.

9207 Allandrus bifasciatus Lec. Gallinas canyon.

SUMMARY OF FAMILIES AND SPECIES.

Cicindelidæ	24	Lampyridæ	25
Carabidæ	124	Malachidæ	13
Amphizoidæ	1	Cleridæ	23
Haliplidæ	1	Ptinidæ	6
Dytiscidæ	21	Lucanidæ	3
Hydrophilidæ	16	Scarabæidæ	89
Silphidæ	7	Spondylidæ	1
Staphylinidæ	48	Cerambycidæ	71
Trichopterygidæ	1	Chrysomelidæ	127
Phalacridæ	5	Bruchidæ	2
Coccinellidæ	25	Tenebrionidæ	61
Endomychidæ	3	Cistelidæ	7
Erotylidæ	2	Othniidæ	1
Colydiidæ	1	Lagriidæ	1
Cucujidæ	1	Monommidæ	1
Cryptophagidæ	4	Melandryidæ	9
Mycetophagidæ	1	Pythidæ	2
Dermestidæ	8	Œdemeridæ	4
Histeridæ	13	Mordellidæ	11
Nitidulidæ	18	Anthicidæ	4
Latridiidæ	5	Meloidæ	41
Trogositidæ	6	Rhipiphoridæ	2
Byrrhidæ	3	Rhynchitidæ	3
Parnidæ	4	Otiorhynchidæ	15
Dascyllidæ	1	Curculionidæ	45
Rhipiceridæ	1	Calandridæ	8
Elateridæ	27	Scolytidæ	20
Buprestidæ	43	Anthribidæ	1

Totals: Families, 56; species, 1010.

CONTRIBUTIONS TOWARDS A CATALOGUE OF THE INSECTS OF KANSAS.

Results of Personal Collecting.

By ELBERT S. TUCKER, Museum Assistant in Systematic Entomology, University of Kansas, Lawrence.

ADDITIONS TO THE KANSAS LIST OF HEMIPTERA-HETEROPTERA.

THE names of forty-eight species or varieties of Hemiptera-Heteroptera are hereby added to the Kansas list which was begun by Prof. E. A. Popenoe in Transactions Kansas Academy of Science, volume IX, pages 62, 63, and recently enlarged by Mr. F. F. Crevecœur, *loc. cit.*, volume XIX, pages 232–234.

All the specimens were collected in Douglas county, except in one instance, which is especially denoted.

Family PENTATOMIDÆ.

(Subfamily *Cydninæ*.)

Cydnus obliquus Uhl. April.
Pangæus uhleri Signoret. May, June, July, October.

(Subfamily *Pentatominæ*.)

Brochymena quadrupustulata Fab. April, August.
Pentatoma ligata Stal. April, October.
Euschistus tristigmus Say, var. pyrrhocerus H.-Sch. July; July, twilight; August.
Menecles insertus Say. April, November.

Family COREIDÆ.

Archimerus calcarator Fab. June; June, twilight.
Acanthocephala instabilis Uhl. October.
terminalis Dallas. June, October.
Leptoglossus oppositus Say. October; October, twilight; November; November, twilight.
Alydus eurinus Say. August.
pilosulus H.-Sch. August.
Harmostes fraterculus Stal. August.
Corizus nigristernum Signoret. May, July.
sidæ Fab. August, on cockle-bur blossoms.

Family LYGÆIDÆ.

Nysius minutus Uhl. July; August; August, at night. Also in Sedgwick county; September.
Belonochilus numenius Say. November.
Phlegyas annulicrus Stal. May, at night.
Sphragisticus nebulosus Fal. August, at night.
Eremocoris ferus Say. August, October.

Family TINGIDÆ.

Corythuca pergandei Heid. May, at night (metatype); October.

Family ARADIDÆ.

Aradus quadrilineatus Say. May.

Family REDUVIDÆ.

Oncerotrachelus acuminatus Say. May.
Pygolampis pectoralis Say. June and July, all at electric light.
Stenopoda culiciformis Fab. July, at street lamp.
Reduvius personatus Linn. May, at night; June, at night; July; August.
Acholla multispinosa De G. July; July, twilight; August; September; October.
Sinea raptoria Stal. June.
Reduviolus pallescens Reut. May, at night.

Family CAPSIDÆ.

Psallus delicatus Uhl. May.
Plagiognathus politus Uhl. June; June, twilight; July, at night; September.
annulatus Uhl. May; June, twilight; August.
Orthotylus flavosparsus Sahl. July, August.
diaphanus Kirsch. Identified by Mr. Otto Heidemann as "probably" this species. June, twilight.
Ceratocapsus (Melinna) fasciatus Uhl. August; August, twilight.
lutescens Reut. August.
Ilnacora (subgenus Corinala) stalii Reut. May, June, August, September.
(Sthenarops) chloris Uhl. June.
malina Uhl. June.
Lygus distantii Atk. (= scutellatus Distant). May, immature; July.
invitus Say, dark variety. June.
monachus Uhl., var. May, June.
plagiatus Uhl. April.
Miridius, not recognizable. August, at night.
Stenodema (Miris) instabilis Uhl. (= affinis Reut.) April, June.

Callimiris tarsalis Reut. July; August, at electric light.

Family BELOSTOMATIDÆ.

Benacus haldemanum (Leidy) Stal. (=grisea Say.) May and July, all at electric light.
Amorgius uhleri Mont. July, at electric light.

ADDITIONS TO THE KANSAS LIST OF HEMIPTERA-HOMOPTERA.

The number of species, including named varieties, hereby added to the Kansas list of Hemiptera-Homoptera is forty-one. With few exceptions, which are fully denoted in each case, all the specimens were collected in Douglas county.

Family CICADIDÆ.

Cicada tibicen Linn. July to first week in October. Also in Sedgwick county, August.

Family MEMBRACIDÆ.

Entylia sinuata Fab., var. bactriana Germ. May; June, twilight.
Ceresa taurina Fitch. June, July.
Stictocephala inermis Fab. August.
Telamona ampelopsidis Harr. June, twilight.
Acutalis calva Say. June.

Family FULGORIDÆ.

Scolops grossus Uhl. July.
Amalopota fitchi Van D. July, at night; August, at night.
Anotia kirkaldyi Ball. August, at night.
Oliarus complectus Ball. June, twilight.
Liburnia lutulenta Van D. April.
ornata Stal. July, twilight; August, twilight.

Family JASSIDÆ.

Idiocerus moniliferæ O. & B. June.
nervatus Van D. April.
snowi G. & B. June, at electric light.
suturalis Fitch. June, at electric light.
Agallia constricta Van D. April; June, twilight; July; July, twilight; August.
Tettigonia hieroglyphica Say, var. dolobrata Ball. June.
Dræculacephala angulifera Wlk. Sedgwick county; June.
Gypona dorsalis Spang. August.
octolineata Say, var. flavilineata Fitch. June; June, at night; July, at electric light and at night; September, at electric light and at night.
Paramesus twiningi Uhl. September, at night.
Platymetopius acutus Say. October.
Deltocephalus nigrifrons Forbes. April; May; May, twilight; July; August.
sylvestris O. & B. May, July.
weedi Van D. June, twilight; August.
Phlepsius decorus O. & B. July, September.
Scaphoideus scalaris Van D. July.
Thamnotettix longula G. & B. April.
fitchi Van D. July.
Gnathodus impictus Van D. June.
Empoasca albolinea Gill. July and September, all at electric light.
viridescens Walsh. May; June, twilight; July; August.
Dicraneura fieberi Loew. May, at night; July.
Typhlocyba rosæ Harr. May, at lamplight; July; August.

Family PSYLLIDÆ.

Aphalara polygoni Foerst. September.
Pachypsylla celtidis-asteriscus Riley. April.
celtidis-mama Riley. March, April, October.
celtidis-minuta Riley. Sedgwick county; April.

Family APHIDIDÆ.

Schizoneura americana Riley. August.
Lachnus longistigma Monell. May, November.

ADDITIONS TO THE KANSAS LIST OF ORTHOPTERA.

If the paper by Mr. F. B. Isely entitled "Notes on Kansas Orthoptera," which was published in Transactions of the Kansas Academy of Science, volume XIX, pages 238–249, be generally regarded as the first state list of the orthopterous insects, the additions which I offer herewith will relate to 26 additional species.

The locality for each species taken, unless especially denoted, was Lawrence, Douglas county.

Family BLATTIDÆ.

Ischnoptera bolliana Saus. June, at night and at electric light; July.
uhleriana Saus. June, and June at electric light.
Themnopteryx deropeltiformis Brun. January, in house; March; April; June, at night.

Family ACRIDIIDÆ.

Paratettix toltecus Saus. May.
Tettigidea lateralis Say. April.
Orphulella pelidna Burm. September.
Arphia carinata Scud. August, at electric light. Also in Sedgwick county; August.
conspersa Scud. Data lost, but Douglas county.
infernalis Saus. April.
Dissosteira longipennis Thom. Sedgwick county; August, and August, at electric light.
Trimerotropis citrina Scud., var. isabelline McNeill. June, at electric light.
Campylacantha acutipennis Scud. October.

Family LOCUSTIDÆ.

Amblycorypha scudderi Brun. July.
Cyrtophyllus perspicillatus Linne. August, at night, captured by aid of light of lantern high up in elm tree.
Conocephalus triops Linne. September, at electric light.
Orchelimum volantum McNeill. July, at electric light.
Xiphidium brevipenne Scud. September.
Ceuthopilus bruneri Scud. June (nymph). Sedgwick county; data lost.
inquinatus Scud. September.
tuckeri Rehn. New species. October, at night.
Udeopsylla robusta Hald. Sedgwick county, on farm; data lost.

Family GRYLLIDÆ.

Tridactylus apicalis Say. May, along sandy banks of Kansas river.
Ellipes minuta Scud. May, along sandy banks of Kansas river.
Gryllus luctuosus A.-Serv. June and July, all at electric light.
Xabea bipunctata De G. August, at electric light.
Hapithes agitator Uhl. August, colony on ailantus bush.

A PRELIMINARY LIST OF THE NEUROPTEROUS INSECTS OF KANSAS.

No attempt has been made hitherto towards publishing a list of the neuropterous insects found in Kansas. Consequently, if the present list be duly considered as forming a preliminary state list, a beginning is made, with fifty-eight species and one variety.

ORDER *EPHEMERIDA.*

Family EPHEMERIDÆ.

All of the specimens were collected at electric light on or near bridge across the Kansas river at Lawrence, except in one instance, which is denoted.

Polymitarchys albus Say. July and August.
Hexagenia bilineata Say. July and September.
venusta Eaton. July and August.
Pentagenia quadripunctata Walsh. June, July, and August.
Siphlurus, species probably new. June and July. The only male imago was taken in July, in daytime, at a distance of more than a mile from the river.
Heptagenia pulchella Walsh. June and July.
Rithogenia elegantula Eaton. July.
Cænis diminuta Wlk. July to September.

ORDER *PLECOPTERA.*

Family PERLIDÆ.

With few exceptions, which are denoted in each case, the specimens were collected at electric light on bridge across the Kansas river at Lawrence.

Acroneuria ruralis Hagen. July.
Perla ephyre Newm. July, at electric light in town, away from river; August, found resting in daytime.
flavescens Walsh. Last week of June, at electric light one mile from river; July, found resting in daytime; and July, at electric light on bridge.
lurida Hagen. July.
Perla xanthenes Newm. July, at electric light in town; August, at electric light on bridge.
Perlinella placida Hagen. July.
species probably new. August, found resting in daytime more than a mile from the river.
Pseudoperla occipitalis Pictet. July.
Chloroperla bilineata Say. May.
Capnia pygmæa Burm. April, on bank of Kansas river.

ORDER *ODONATA.*

All Douglas county specimens.

Family CALOPTERYGIDÆ.

Calopteryx maculata Palisot de Beauvois. June.
Hetærina basalis Hagen. August.

Family AGRIONIDÆ.

Lestes forcipatus Rambur. May, at night.
rectangularis Say. August.
unguiculatus Hagen. June, August.
Enallagma civile Hagen. June.
Ischnura verticalis Say. May, June.

Family GOMPHIDÆ.

Herpetogomphus designatus Selys. July.
Gomphus amnisola Walsh. June.

Family ÆSCHNIDÆ.

Anax junius Drury. May, August.

Family LIBELLULIDÆ.

Perithemis domitia Drury. July.
Celithemis eponina Drury. July.
Sympetrum corruptum Hagen. October.
rubicundulum Say. September.
rubicundulum Say, var. assimilatum Uhl. September.
vicinum Hagen. July.
Pachydiplax longipennis Burm. September.

ORDER *ISOPTERA.*

Family TERMITIDÆ.

Termes flavipes Koll. Douglas county, July, from rotten oak stringers in sidewalk.

ORDER *CORRODENTIA.*

Specimens taken in Douglas county.

Family PSOCIDÆ.

Pterodela pedicularia Linne. September.

Family ATROPIDÆ.

Atrops divinatoria Fab. September, October, November.

ORDER *NEUROPTERA.*

Unless especially mentioned, specimens were taken in Douglas county.

Family SIALIDÆ.

Chauliodes rasticornis Rambur. May, at electric light near river.
Corydalis cornuta Linne. July and August, all at electric light, usually near river. Larvæ collected in July.

Family CHRYSOPIDÆ.

Chrysopa nigricornis Burm. April, at electric light; June; October.
oculata Say. May; June, twilight; July; July, twilight. Also in Sedgwick county; August.
plorabunda Fitch. April; June; July, at night; August; August, at night; November. Also in Sedgwick county; August.
rufilabris Burm. July, twilight; August, at night.

Family HEMEROBIDÆ.

Hemerobius stigmaterus Fitch. April; May; May, at night; August, at night; September, at night; October.
Sympherobius amiculus Fitch. June.
perparvus McLach. April, at lamp light.

Family MYRMELEONIDÆ.

Brachynemurus abdominalis Say. August; August, at night. Also in Sedgwick county; August.

Family CONIOPTERYGIDÆ.

Coniopteryx vicina Hagen. May.

ORDER *MECOPTERA.*

Douglas county specimens.

Family PANORPIDÆ.

Bittacus stigmaterus Say. July, at night; August.
strigosus Hagen. June, July.

ORDER *TRICHOPTERA.*

All except the first species and some examples of the last were collected at electric light on the bridge crossing the Kansas river, at Lawrence.

Family LIMNEPHILIDÆ.

Apatania pallida? Hagen. October, attracted by lamp light.

Family LEPTOCERIDÆ.

Leptocerus dilutus Hagen. July to October.
Setodes albida Wlk. July to September.
uwarowii Koll. July to September.
Mystacides punctata Banks. July to September (type, August).

Family HYDROPSYCHIDÆ.

Hydropsyche kansensis Banks. June to September.
phalerata Hagen. May to September.
scalaris Hagen. June to October; also May, at night; April; August in house, attracted by light.

ADDITIONS TO THE KANSAS LIST OF DIPTERA.

So far as determined, nearly half of the species of Diptera taken by me in Kansas are new to the state lists, the preliminary one being published by Dr. F. H. Snow, in the Kansas University Science Bulletin, volume II, No. 5, to which additions were made by Mr. F. F. Crevecœur, in Transactions of the Kansas Academy of Science, volume XX, pages 90–96. By actual count, the names of 142 different kinds of flies are herewith added to the Kansas list. In this number, two species and one variety are based on my own descriptions.

Unless especially denoted, all specimens were collected in Douglas county.

Family TIPULIDÆ.

Dicranomyia longipennis Schum. May, at night; August.
Pachyrhina ferruginea Fab. May, June, August.

Family CHIRONOMIDÆ.

Ceratopogon bipunctatus Linne. May, in window; June, twilight; August. Also in Sedgwick county; April.
pilosulus Coq. September, at electric light.
specularis Coq. May.
squamipes Coq. April, at night; May, in windows of house in early morning; May, at night; June; June, at night; July, August, September.
Ablabesmyia (Tanypus) carnea Fab., variety *b*, Joh. April.
monilis Linne. April.
nigropunctata Stgr. June; June, at night; July.
Tanypus stellatus Coq. September, at electric light.
Chironomus albipennis Meig. July, at electric light.
attenuatus? Wlk. June; July, at electric light; August.
decorus Joh. May; June; July, at electric light; September, at electric light.
flavus Joh. July, at electric light; August; September, at electric light.
frequens Joh. July and August, all at electric light.
fulviventris Joh. July, at electric light.
fulvus Joh. June, at electric light.
fumidus Joh. July, at electric light.
halteralis Coq. July, at electric light.
lineatus Say. July, at electric light.
modestus Say. June.
nigricans Joh. July, at electric light.
pallidus Joh. June, twilight; July, at electric light.
riparius Meig. March, April.
scalænus Schrk, var. June, twilight.
similis Joh. May; May, twilight; June, at night; September, in window.
stigmaterus Say. July and September, all at electric light.

Family CHIRONOMIDÆ.

Cricotopus sylvestris Fab. April.
trifiasciatus Panz. September, at electric light.
Comptocladius byssinus Schrk. April, May. Also in Sedgwick county; April.
Orthocladius nivoriundus Fitch. May.
politus Coq. July, at electric light.
Tanytarsus nigripulus Joh. March; April, at night.

Family CULICIDÆ.

Culex impiger Wlk. May, at night; July; July, twilight.
pipiens Linne. May; June; June, twilight; July, twilight; August; November.
restuans Thbld. May, May, twilight; June; June, twilight; July; July, twilight; August; August, twilight; September, in house; October.
sylvestris Thbld. April; May, at night and in house; June; June, twilight; July; July, twilight; August; October.
Tæniorhynchus perturbans Wlk. August, twilight.
Sayomia punctipennis Say. July, at electric light; August, at night.

Family MYCETOPHILIDÆ.

Ceroplatus terminalis Coq. July, September.
Mycetophila contigua Wlk. March.
discoides Say. March.

Family BIBIONIDÆ.

Bibio articulatus Say. April, May.
Dilophus serotinus Loew. October.
Scatopse atrata Say. April.
notata Linne. April, in window; May.
pygmæa Loew. April.

Family RHYPHIDÆ.

Rhyphus alternatus Say. April.
punctatus Fab. April; June; June, twilight; July, twilight.

Family STRATIOMYIDÆ.

Allognosta fuscitarsis Say. May, June, July, August.
Sargus elegans Loew. June. Also in Sedgwick county; April.

Family TABANIDÆ.

Tabanus quinquevittatus Wied. June.

Family THEREVIDÆ.

Thereva melanoneura Loew. May.

Family ASILIDÆ.

Scleropogon picticornis Loew. Sedgwick county; August.
Heteropogon phœnicurus Loew. August.
Deromyia ternata Loew. July, twilight.
Cerotainia macrocera Say. July.
Erax bastardii Macq. July.
Tolmerus annulipes Macq. New variety, delusus Tkr. June.
prairiensis Tkr. New species. Sedgwick county; August.

Family DOLICHOPODIDÆ.

Psilopodinus scobinator Loew. June, twilight.
Diaphorus spectabilis Loew. June, twilight; July, twilight; August.
Asyndetus syntermoides Wheeler. July.
Chrysotus auratus Leow. June.
longimanus Loew. July.
obliquus Loew. June, twilight; July; August.
pallipes Loew. July, twilight.
picticarnis Loew. August.
vividus Loew. May.
Sympycnus lineatus Loew. May; May, at night; June; June, twilight; July, twilight.
Dolichopus vittatus Loew. June, twilight.
Gymnopternus crassicauda Loew. June.
humilis Loew. June.

Family EMPIDIDÆ.

Drapetis latipennis Melander. June.
Syneches pusillus Loew. July, twilight.
Rhamphomyia irregularis Loew. April.

Family LONCHOPTERIDÆ.

Lonchoptera lutea Panz. May.

Family PHORIDÆ.

Phora incisuralis Loew. June, twilight.
multiseriata Ald. May.
Aphiochæta agarici Lint. May.
epeiræ Brues. May.
longifrons Brues. June, twilight.

Family PLATYPEZIDÆ.

Platypeza obscura Loew. July, twilight.
pallipes Loew. June.

Family PIPUNCULIDÆ.

Chalarus spurious Fal. June, twilight.
Pipunculus atlanticus Hough. June, twilight.
fuscus Loew. July, twilight.

Family SYRPHIDÆ.

Chrysotoxum laterale Loew., var. September.
Pipiza pisticoides Will. Sedgwick county; April.
Myiolepta nigra Loew. May, in window.
varipes Loew. May.
Ocyptamus fuscipennis Say. July.
Rhingia nasica Say. June, twilight.
Ceria willistonii Kahl. June.

Family TACHINIDÆ.

Eulasiona comstockii Twns. April.
Electops melissopodis Coq. October.
Hypostena barbata Coq. Sedgwick county; April.

Family TACHINIDÆ.

Exorista blanda O. S. June, twilight; July.
griseomicans Van der Wulp. May.
Phorocera leucaniæ Coq. July.
Acemyia dentata Coq. October.
Tachina robusta Twns. April, May.
Hilarella aristalis Coq. July.

Family DEXIIDÆ.

Melanophora roralis Linne. May, June, July, September.

Family SARCOPHAGIDÆ.

Sarcophaga (Helicobia) helicis Twns. July. Also in Sedgwick county; April.

Family ANTHOMYIDÆ.

Hyetodesia (Phaonia) mulcata? Giglio-Tos. April.
Limnophora narona Wlk. June; July; July, twilight. Also in Sedgwick county; April.
Hylemyia lipsia Wlk. April; June; July; July, twilight; August.
Forbia fusciceps Zett. April; April, at night; June; June, twilight. Also in Sedgwick county; April.
Cœnosia lata Wlk. April, July, August.
Schœnomyza dorsalis Loew. May, June.

Family HELOMYZIDÆ.

Leria pectinata Loew. April, at night.

Family BORBORIDÆ.

Limosina evanescens Tkr. New species. June; June, twilight; July, at electric light.

Family SCIOMYZIDÆ.

Sciomyza obtusa Fal. June.

Family SAPROMYZIDÆ.

Lonchæ vaginalis Fal. June.
Lauxania gracilipes Loew. July, twilight.
Sapromyza innuba? Giglio-Tos. April.
quadrilineata Loew. April.

Family ORTALIDÆ.

Tetanops integra Loew. May.
Pseudotephritis vau Say. June.
Seoptera vibrans Linne. June.

Family SEPSIDÆ.

Nemopoda minuta Wied. June, twilight; July; July, twilight.

Family PSILIDÆ.

Chyliza apicalis Loew. June, twilight.

Family EPHYDRIDÆ.

Hyadina albovenosa Coq. April, at night.

Family OSCINIDÆ.

Chlorops palpalis Adams. May, twilight.
Hippelates flavipes Loew. June. Also in Sedgwick county; April.
pusio Loew. June, twilight; August. Also in Sedgwick county; April.
Oscinis carbonaria Loew. April, at night; May, at night.
coxendix Fitch. April; June, twilight. Also in Sedgwick county; April.
decipiens Loew. July.
soror Macq. May, June.

Famils DROSOPHILIDÆ.

Drosophila (Scaptomyza) adusta Loew. May, at night; August.
amœna Loew. April.
funebris Fab. May; June; July; July, twilight; October; and November, in kitchen.
(Scaptomyza) graminum Fal. April; April, at night.

Family AGROMYZIDÆ.

Phytomyza diminuta Loew. May; June, twilight and at night.
Ceratomyza dorsalis Loew. May, at electric light; June.
Agromyza æneiventris Fal. July.
parvicornis Loew. Sedgwick county; April.
Desmometopa latipes Meig. June.
m-nigrum Zett. June.
Ophthalmomyia lacteipennis Loew. Sedgwick county; August, in windows of farmhouse.

NOTICE OF NEW ELEMENTS IN UINTACRINUS.

By H. T. Martin, University of Kansas, Lawrence.

THE present notice is to call attention to some new structures discovered on a small portion of a weathered crinoidal slab in the writer's collection, supplemented by several specimens belonging to the University collection.

The feature that is of particular interest is the course of the axial nerve system inside the cup and extending as far as the second secundibrachs.

The discovery was made too late for a paper to be read before the Academy. Consequently, a full description, now in preparation, with accompanying plates, will appear in the next *Kansas University Science Bullletin.*

SOILS AND BACTERIA.*

By LYMAN C. WOOSTER, Ph. D., State Normal School, Emporia.

OWING to the inexact forms of statement used by many writers, most people believe that plants use as foods certain minerals found in soils, while animals eat organic materials found in plants and other animals. Any one who knows aught of the needs of plants and animals and of the nature of foods knows that plants and animals must both have for their tissues and activities starch, sugar, oils, and proteids; and that no plant, except a few bacteria, can get energy and tissue foods directly from the mineral world. Water, carbon dioxid, potassium and sodium nitrates, ammonia in some form, sodium chlorid, calcium sulfate (gypsum), magnesium sulfate (epsom salts), calcium phosphate and some soluble compound of iron are merely the crude materials out of which green plants, in the presence of sunlight or the light of the electric arc, build their foods, such as starch, oil, and the proteids. The minerals named above are crude food materials, and are foods in no other sense; but their presence in soils is as necessary to complex plants as are brick, mortar and lumber to the house-builder.

The amount of these crude food materials used by a crop of wheat, for example, is surprisingly large. From a single farm of 160 acres, where exclusive wheat farming is followed, there is an annual waste of fertility equivalent to 28,500 pounds of nitrogen, 5000 pounds of potash, 3000 pounds of phosphoric acid, and 1600 pounds of lime. Unless these minerals are returned to the soil, the land must continue to diminish in productiveness till it finally becomes barren. This was the fate of the old tobacco plantations of old Virginia, and is soon, certainly within fifty years, to be the result of continuous wheat cropping in Kansas without the use of fertilizers.

The humus and bacteria of the soil are most directly concerned with its nitrogen content, and it is to these elements of fertility that I wish to address myself.

It is very unfortunate for the farmer that no cultivated plant can use uncombined nitrogen as a crude food material, for the atmosphere is four-fifths nitrogen. The nitrogen used by plants

*In preparing this paper I have freely used the observations and experiments described in two standard works, "Bacteria," by Geo. Newman, published by G. P. Putnam's Sons, and "Physics of Agriculture," by F. H. King, published by author, Madison, Wis., together with my own personal observations and experiences. These have served as the bases of the inductions, which I trust will be of some service to the farmers of our state.— L. C. W.

large enough to be seen by the unaided eye must be in the form of a nitrate, such as Chili saltpeter or common saltpeter, or possibly in some salt of ammonia.

Could cultivated plants use atmospheric nitrogen directly, the chief problem of soil fertility would be solved. More than 33,000 tons of nitrogen rests on each acre of ground. Contained in Chili saltpeter, this amount of nitrogen would be worth $4,000,000 per acre, and the supply would be inexhaustible. So far as is now known, bacteria alone, of all plants, can use nitrogen and the nitrites as crude mineral foods. Fortunately they excrete the substances as nitrates. The higher plants then absorb the nitrates and the other mineral food materials and prepare the various proteids to increase their cell protoplasm.

Soil bacteria are of many kinds; and the number of individuals of each kind, even in a handful of soil, is almost beyond comprehension. One gram (one-fourth teaspoonful) of virgin soil contains 53,436 bacteria; and the same amount of soil from a cemetery supports 363,411 bacteria. Few are found below a depth of six feet. Their rate of increase in numbers through cell division is equally remarkable. Milk fresh from the cow contains on the average 15,000 bacteria to the cubic centimeter (one-fourth teaspoonful); milk four hours old has in the same volume 100,000 bacteria, fifteen hours old, 6,000,000, and ten days old, 1,000,000,000 of these remarkable plants.

Though the systematic study of bacteria is less than a half a century old, and though each species varies in form and activity through wide limits, in a few hours, in different environments, 600 or 700 kinds have been named and described. These kinds may be grouped, for the purposes of this paper, in five or six classes:

1. The bacteria of putrefaction.
2. The air-hating, denitrifying bacteria.
3. The air-loving, nitrifying becteria.
4. The nitrogen-fixing, root-tubercle bacteria.
5. The pathogenic bacterta.

1. The bacteria of putrefaction reduce the bodies of plants and animals to the condition called humus in soils. The complex organic compounds are broken down, resulting in a release of energy and much cell-substance material for the bacteria and in the evolution of various gases, such as carbon dioxid, dihydric sulfid, ammonia, and probably some nitrogen. However, the work of these bacteria seems to be necessary in order that organic matter

may be reduced to a usable condition. Among these bacteria are: *Bacillius colli*, *B. mycoides*, *B. mesentericus*, *B. liquidus*, *B. prodigiosus*, *B. ramosus*, *B. vermicularis*, *B. liquefaciens* and many members of the great family of *Proteus*.

2. The air-hating, denitrifying bacteria are responsible for the more or less complete destruction of the nitrates in the farm and commercial fertilizers, when these are buried in such a way that air is largely excluded. They also do an important work in assisting the bacteria of putrefaction in destroying excrement in cesspools and retention vats, where sewage is detained for work of this character. These bacteria work best where the supply of air is limited and the amount of organic matter great. The organic matter is oxidized with oxygen taken from the nitrates, and a distinct rise of temperature results, as may be seen in heaps of manure. Much nitrogen, consequently, is lost to the manure and soil. Among the denitrifying bacteria that have been isolated are: *Bacillus fluorescens non-liquefaciens*, *Mycoderma ureæ*, and some of the *Staphylococci*.

The very effective character of the work done by the putrefactive and denitrifying bacteria was proved by the late Colonel Waring, the eminent sanitary engineer. He kept two tons of dry earth for use over and over in dry-earth closets. The closets were emptied once in two months in heaps on the floor of a dry cellar. This material was used, in all, about ten times, and then the material was analyzed for the amount of nitrogen it contained. It was found that 4000 pounds of the soil had only eleven pounds of nitrogen, though at least 230 pounds had been added to it and it contained three pounds at first.

It would seem, then, from this and other experiments, that farm manure would better be spread in layers, in the barn-yard, a few inches thick, till it is somewhat decomposed, and then spread thinly over the fields and not plowed in deeply, unless the surface can be frequently cultivated, so the air can have free access to every portion of the soil containing the fertilizer. In this way the air-hating bacteria will be deterred from working in the fertilizer overmuch.

3. The work of the air-loving, nitrifying bacteria beautifully complements that of the denitrifying bacteria, if they are given a fair chance. As their name implies, they work best in loose soil near the surface of the ground, and are nearly absent from soil at a greater depth than two feet. They are of several kinds, and are very numerous in rich, porous humus. Some change ammonia to nitrites, and others change nitrites to nitrates. They do not work

in acid soils, nor in soils strongly alkaline, but do best in soils faintly alkaline. Acid soils must be neutralized by alkaline earths, such as quicklime and wood ashes; alkali spots should be sanded and drained, or crude sulfuric and nitric acids may be sprinkled over such places.

The air-loving, nitrifying bacteria work on the surface of sewage in the retention vats, and very vigorously when it has been passed out into small, open fields, where the sewage may stand a few days, spread out in a stream a few inches thick. The bacteria reduce organic matter unreduced and oxidize the ammonia, nitrites, and sulfites. When this work has been completed, the sewage is ready to be used as a fertilizer.

The nitrifying bacteria use various organic matters (of which phosphates are essential constituents) as foods, though the remarkable fact has been discovered that the nitrifying organisms can develop and perform all their functions on inorganic materials. They have the power to live and grow in a medium consisting solely of acid carbonates of sodium and calcium in an ammoniacal solution undergoing nitrification. No other plants destitute of chlorophyll can do this.

The nitrous bacteria have been named *Nitrosomonas* and *Nitrosococcus*, and the nitric organism the *Nitrobacter*. These are evidently most valuable to all farm crops, as without them the soil would soon become barren.

4. The root-tubercle bacteria are recent discoveries. For a long time it has been known that the clovers, peas, beans and other legumes not only do not exhaust the soil, but even leave it in better condition than before the crop was grown. Certain tubercles on the roots of these plants are crowded with bacteria which are now known to possess the power to use the free nitrogen and oxygen of the air in preparing those compounds of nitrogen that serve as crude food materials to the host-plants. The mutual relation existing between the legume and the bacteria is not well understood, but there is no question as to the benefit accruing to the host.

Certain companies are now preparing cultures of bacteria, appropriate for use on the several crops of legumes, to sell to farmers and gardeners. The Western Nitrogen Culture Company, of Topeka, prepares packets of bacteria and food, to be used on sixteen important legumes, one packet for each kind. The tubercle bacteria do not thrive in acid or strongly alkaline soils, but in average Kansas soil they multiply rapidly, and their excretions in the tubercles cause a greatly increased growth of the legume and at

the same time help to enrich the soil. These bacteria, beyond question, increase the growth of alfalfa and Red clover. Indeed, it is largely because of their presence in the soil that these crops continue to flourish in Kansas.

The root-tubercle bacteria are air lovers, and the soil must be kept loose by cultivation or kept well shaded by the crop when wet, or alfalfa, clover and the other legumes will not make their best crop. Dressings of land plaster (gypsum) help these plants wonderfully, but a porous soil is of the first importance.

In the best soils the pore space equals one-half the volume of the soil. In clay soils it is more; in sandy soils, strangely enough, it is less. As pore space is either air space or water space, the importance of thorough water drainage, both surface and subsoil, is evident. When the pore space is filled with air, the air-loving, nitrifying bacteria and the root-tubercle bacteria flourish best and the heaviest crops are harvested. When the pore space is largely reduced by plowing when the soil is too wet, or is filled with floodwater, the air-hating, denitrifying bacteria rob the soil of its nitrates, and light crops are harvested. Puddled soil may be excellent for dirt roads—indeed, makes the best roads when quickly dried, with the pore space absent or largely reduced—but, on the farm, it cannot grow valuable crops.

5. Pathogenic bacteria are frequently found in rich soils. Among the most numerous and dangerous of these is the bacillus of tetanus (lockjaw). No wound received in stables is a safe wound. The bacillus works in the wound; and lockjaw is caused by its excretions, which are absorbed by the blood and carried to the nerve centers.

The bacteria which cause typhoid fever and tuberculosis are likewise found in rich soils. The germs of typhoid fever may live in soil impregnated with the excretions of a typhoid patient 456 days, and the germs of tuberculosis are found to be alive in soil several weeks after having been added to it. All germs of this character should certainly be destroyed before they are thrown upon soil.

Other disease germs are known to exist in the soil, some of bacteria and others of animals—the protozoa. It is probable that some of the latter get into the drinking water and cause dysentery and, possibly, appendicitis.

The soils about buildings are being studied with the greatest care, and, while very much remains for future work, enough is now known to make it certain that water from deep wells, wells with

cemented walls and situated on highest ground near house, or else boiled water, is the only water safe to drink, if one would escape these deadly diseases.

All that has been given in this paper is in full accord with the rules established empirically by our most successful farmers. The use of fertilizers, the thorough cultivation of the soil and the rotation of crops are the A-B-C's of profitable farming. The one supplies the plants with necessary mineral food elements, the next aerates the soil for the air-loving, nitrifying bacteria, and the last gives time for the rise from the subsoil of the mineral food elements peculiar to each crop.

Any of these three things can be overdone, especially the second and third. Plowing in deeply much coarse material so opens up the soil that the water to a depth hurtful to the crop is wasted. On the other hand, thin surface cultivation, producing a soil mulch, is very beneficial in dry seasons, as the amount of soil thoroughly dried is small, and this thin layer of loose earth stops the water that is rising from the greater depths through capillary tubes. Taking as a standard soil not cultivated, the water saved by a cultivation one inch deep, once a week, was nearly 25 per cent., twice a week, was over 27 per cent.; three inches deep, was 27 per cent. and 32 per cent. for once and twice a week respectively.

Crop rotation is found to be much better for soil bacteria of the helpful kinds than absolute rest. The latter, where there is no cultivation, enables the air-hating, denitrifying bacteria to destroy more fertilizers than the rest brings in from rock, gravel and subsoil disintegration.

ADDITIONS TO THE LIST OF KANSAS BIRDS.

By F. H. Snow, University of Kansas, Lawrence.

IN the spring of 1905, from April 27 to May 9, Mr. Edward R. Warren collected birds and mammals at Monon, in Baca county, Colorado, which lies immediately west of Stanton county, Kansas. An annotated list of these birds was published by Mr. Warren in *The Condor* of January, 1906. Monon is a post-office station which appears on the official railroad map of Kansas of 1901, about one-half mile east of the Colorado line. For some reason Mr. Johnston, the postmaster, moved his residence just across the state line and took the post-office with him; so that Monon, formerly on the western edge of Kansas, is now on the eastern edge of Colorado, hardly half a mile from the state line.

Among the birds taken by Mr. Warren were eight species not up to this time recorded as Kansas species but which seem to me to be properly entitled to a place on the Kansas list. Some of these species were taken in a small grove of cottonwood trees, the western portion of which lies in Colorado and the eastern portion in Kansas.

The remarks within the quotation marks in the following list are from Mr. Warren's article in *The Condor:*

The eight species which I consider entitled to a place in the Kansas avifauna are as follows:

I. The Scaled Partridge (*Callipepla squamator* Vig.) Previously recorded from north to central and western Texas, New Mexico, and southern Arizona. (See the A. O. U. Check-list of North American Birds.) "This species has made its appearance at Monon within the last fourteen years. They are gradually working their way into Kansas. Professor Cooke, in his Second Appendix to the Birds of Colorado, speaks of what he calls a queer state of affairs regarding the occurrence of this species in Colorado, and notes that at first it was supposed to be very rare, and then it was found to be common in the cedars, and at the time of the publication of this appendix the birds had found their way to the Arkansas river at Rocky Ford. My observations show that they are common in the cedars, and that they are still working east."

II. The Spurred Towhee (*Pipilo maculatus megalonyx* Baird). Previously recorded from the Rocky Mountain region of

the United States to California. "Although towhees were not uncommon at that time at Monon, two specimens were unfortunately the only ones collected."

III. The Green-tailed Towhee (*Pipilo chlorurus* Towns.) Recorded as occupying the interior plateau region of the United States. "First seen at Monon May 3, when there were many in the cottonwoods along Bear creek."

IV. Swainson's Vireo (*Vireo gilvus swainsoni*). "One specimen taken May 3 at Monon, and another at Springfield May 30, both in the trees along Bear creek."

V. Virginia's Warbler (*Helminthophila virginiæ*). Recorded from the Rocky Mountain region of the United States. "A single specimen, a male, taken May 3, at Monon, which extends its range very much to the east."

VI. Macgillivray's Warbler (*Geothlypis macgillivrayi* Aud.) This species was taken at Springfield, twenty-five miles west of the state line. It is a migratory bird, has been taken at Gainesville, Tex., and in western Nebraska, and must pass through Kansas in the migrating seasons. "Seen only near Springfield, as usual among the trees along Bear creek. First seen May 11; several seen the next few days. The last one seen was a male of the preceding year in immature plumage, taken May 30."

VII. The Sage Thrasher (*Oroscoptes montanus* Towns.) This species was taken at Springfield. It has also been taken in western Nebraska and without doubt is a Kansas bird.

VIII. The Dwarf Hermit Thrush (*Hylocichla aonalaschkæ* Gmel.) Previously recorded as occurring in the Pacific Coast region from Alaska to Lower California and western Mexico, east, during migrations, to Nevada and Arizona. "First seen May 1, at Monon, where one was shot in a tree beside Bear creek. On May 11, at Springfield, they seemed common among the trees along Bear creek. Disappeared a day or two after."

A very interesting capture during the present year was a specimen of the Chaparral cock or Road-runner (*Geococyx californianus* Less.), at Emporia, Kan. This capture was made by the children of Mr. David Taylor, of Emporia, by whom it was kept alive as a pet. This information was received from Prof. L. C. Wooster, of the State Normal School, on June 3.

NOTES ON THE KANSAS BIRD LIST.

By D. E. Lantz, Washington, D. C.

NORTH AMERICAN ornitholgy has made considerable advancement in recent years, but Kansas observers have not kept up with the general progress. In spite of the recent publication in the Transactions of the Academy of Science of two lists of the birds of the state, we have at present no state list that properly represents the actual bird fauna of Kansas.

The geographical position of Kansas makes its fauna of peculiar interest. It contains the division between two life zones—the Upper and Lower Austral; and since its western part is in the semiarid plains, we have representatives of four faunal areas within her borders. The Alleghanian fauna is the most important, being dominant over approximately the eastern two-thirds of the state, except an irregular strip on the south, which belongs to the Carolinian. The western third of the state is principally Upper Sonoran, but in the portion from the Arkansas valley southward the Lower Sonoran forms are dominant. However, these faunal areas are not well defined for the various species of birds, and the distribution of many of them in Kansas is practically unknown. Many common Eastern birds are replaced in the West by well-marked races, or subspecies, which belong to the plains or plateau faunas. In many of these cases Kansas has representatives of both forms, one not hitherto reported; in others, of but one, with the wrong form now credited to the state. Besides, the Southern fauna—the Lower Austral forms that come into the state—have surely not all been reported. In these respects our Kansas bird list is far from being perfect.

In regard to nomenclature, our list has not been kept "up to date." When, in 1897, I presented to the Academy a "Review of Kansas Ornithology," the attempt was to show the historical side of the work already done by observers in the state. Unfortunately I overlooked the eighth supplement to the A. O. U. Check-list, and the list I then published contained eleven bird names that had become obsolete. When, four years later, Doctor Snow's "Catalogue of Kansas Birds" was published, two additional supplements to the A. O. U. list had appeared, but the nomenclature of the "Twentieth Century Catalogue" contained none of the changes made by the A. O. U. committee in either the eighth, ninth or tenth supplements.

Since then three more supplements have appeared, and the Kansas list has now many more obsolete names.

In the past ten years many new facts of bird distribution have been discovered. The study of the Texas fauna by the United States Biological Survey, as well as the careful work done by ornithologists in Colorado and Nebraska, has shown how little is actually known of Kansas birds. Kansas ornithologists have many problems left for solution before an absolutely correct list of our birds can be prepared. An examination of the references in the first three volumes of Robert Ridgway's monumental work, "The Birds of North and Middle America," has shown some of these deficiencies, a few of which I will mention.

Do both forms of the Evening grosbeak occur in Kansas, or only the Western?

Have we the Red crossbill or only the form listed of *Loxia curvirostra stricklandi*, but which is really *L. c. bendirei?*

Does the Western goldfinch belong to the fauna of our western counties? It has been taken in summer in Nebraska.

How far east in Kansas does the Western lark sparrow (*Chondestes grammacus strigatus*) range?

Both forms of the Vesper sparrow occur. How far west does *Poaecetes gramineus* range before being replaced by *confinis*, which occurs over the greater part of western Kansas?

The Alaskan longspur may occur in western Kansas in winter. No records of its capture have been made. The Western form (*bimaculatus*) is our most common Grasshopper sparrow. Do we have also the Eastern form, now credited to the state? This will probably be determined in the affirmative.

Baird's sparrow should be abundant in migration over a large part of western Kansas. There are no records of its capture.

Do we have the Western form of Henslow's sparrow? It has been found breeding in Nebraska.

How many forms of *Junco* enter the state? *Junco oregonus* (or *oreganus*) does *not* occur. Our birds are *shufeldti* or *montanus*, probably both. *Junco caniceps* may also occur in the western part. *Junco hyemalis* is the common bird of the state.

How far east does the Western Tree sparrow range? We should have the Western Field sparrow and possibly the Western Chipping sparrow.

Brewer's sparrow may breed in northwestern Kansas. It has not been reported in the state.

The Green-tailed towhee may possibly be found in the canyons of western Kansas.

Our common Blue grosbeak in central Kansas is the Western form, *lazula*. The Eastern form, now on the list, may also occur in eastern Kansas.

Here are a score of questions relating to our sparrows which have not been settled. Other groups present similar unsettled problems. For instance, how many forms of the Red-winged blackbird occur in the state? It is certain that the large-billed form (*fortis*) should be added to the state list. The Migrant shrike (*Lanius ludovicianus migrans*) should probably be substituted for the Loggerhead shrike. Our Long-billed marsh wren is the prairie form *iliachus*. Baird's wren does not occur north of Mexico. The Kansas Bewick wren is probably *Thryomanes bewicki cryptus* for the greater part of the state. Typical *bewickii* may occur in eastern Kansas. Only one form of mocking-bird appears on the list. The White-winged form is certainly present in western Kansas. Possibly two forms of Traill flycatcher occur.

The present would be an inopportune time to attempt a revision of the state list. The nomenclature committee of the American Ornithologists' Union are at work upon a new check-list of North American birds. A rearrangement of families is expected, as well as radical changes in the names of birds. A state list prepared in advance of the publication of the conclusions of the American Ornithologists' Union committee would be almost worthless.

In the meantime a study of the birds of the state for the purpose of determining the actual distribution of Eastern and Western forms is all important. Specimens in breeding plumage as well as winter birds should be collected. Especially is it worth while to study the birds of southeast and southwest Kansas, to determine the Carolinian and Lower Sonoran forms that enter the state. While but little is known of the birds that breed in the extreme northwest and southwest parts of the state, a winter study of the birds of those sections would also yield unreported forms.

In addition to field-work, it is desirable that the various public and private collections of bird skins in the state should be submitted to competent authority for comparison with types and properly determined specimens. This can be done only in the larger museums, and probably best in the United States National Museum, in Washington.

Should these suggestions be carried out, I have no doubt that the Kansas bird list will be considerably increased, and the total of forms approach very nearly to the 394 and 400 accredited, respectively, to Colorado and Nebraska.

ADDITIONS AND CORRECTIONS TO THE LIST OF KANSAS MAMMALS.

By D. E. Lantz, Washington, D. C.

SINCE the publication, two years ago, of my list of Kansas mammals, further work in the field, together with comparisons of material in the collections at Washington, have made it possible to correct some errors of the former paper and to add several species to the state list.

I.—ADDITIONS.

1. Citellus tridecemlineatus texensis (Merriam). Texas Spermophile.
   This red variety of the Striped prairie squirrel was taken by me last year at several Oklahoma places and at Medicine Lodge, Kan. I find also that Vernon Bailey had taken specimens of this subspecies at Kiowa, Kan., in 1892.
2. Peromyscus leucopus (Rafin.) White-footed Deer Mouse.
   This woodland form of the White-footed mouse was found abundant at Manhattan last year. The collections of the United States National Museum and the Biological Survey contain specimens from Leavenworth, Onaga, Fort Riley, and Neosho Falls.
3. Peromyscus luteus (Osgood). Buff Deer Mouse.
   Taken by me in 1905 at Medicine Lodge and Hays City, and by J. Alden Loring, previously, at Pendennis. The Hays City specimens are intermediates between *P. luteus* and *P. michiganensis*, with some individuals approaching very nearly to typical *luteus*.
4. Peromyscus attwateri Allen. Attwater Deer Mouse.
   Four specimens taken in 1892, by Vernon Bailey, at Cedar Vale, Kan., and now in the Biological Survey collection, belong to this Southern form, which has also been found at Dougherty, I. T., by Thaddeus Surber, of the Field Museum.
5. Reithrodontomys griseus Bailey. Little Gray Harvest Mouse.
   This Harvest mouse was recently described from Texas (Bailey, N. A. Fauna, No. 25, p. 106, 1905). Specimens in the Biological Survey collection from Onaga, Pendennis and Wa Keeney have been referred to the new form. It seems to occur at the three Kansas points named, associated with *R. dychei* but is not so abundant as that species. It differs from *dychei* in smaller size, grayer color, and shorter skull.
6. Neotoma micropus Baird. Small-footed Wood Rat.
   Wood rats in the Kansas State Agricultural College museum, secured at Sun, Barber county, prove to be of this species. This rat had been previously taken in Woodward, Woods and Beaver counties, Oklahoma, and is probably common in the gypsum hills of southern Kansas.

7. Geomys breviceps llanensis Bailey. Mesquite Plains Gopher.
   This pocket-gopher was described last year by Bailey (N. A. Fauna, No. 25, p. 129, 1905). It was taken by me at Medicine Lodge, Kan., and to it are to be referred nearly all the specimens from southern Kansas which have hitherto been regarded as intermediates between the three forms, *G. breviceps*, *G. bursarius*, and *G. luteus*.
8. Corynorhinus macrotis pallescens Miller. Pallid Big-eared Bat.
   Bats with long ears have frequently been reported from the gypsum caves in Oklahoma and southern Kansas, but specimens were not available to determine the species. I heard of them last year (1905) at Alva and Medicine Lodge. Later, collectors from the State Agricultural College secured a specimen at Sun. This I have not seen; but a specimen from Alva, Okla., was sent me last spring by Prof. G. W. Stevens, of the Northwestern Normal School, and was identified by Mr. Gerrit S. Miller, jr., as the Pallid Big-eared bat. I have no doubt that this is the only form of the genus that occurs in Kansas. The bat is quite rare, there being but a few scattered records of its occurrence. It has been taken once in Texas, once in the Black Hills, South Dakota, and once in Larimer county, Colorado. These are the only previous records east of the Rocky Mountains.

II.—ELIMINATIONS FROM THE LIST.

1. Peromyscus texanus (Woodhouse).
   This was reported from Pendennis, but is undoubtedly *P. luteus* and not the Texas species.
2. Peromyscus texanus nebrascensis Mearns.
   While it is possible that this mouse occurs in the extreme western part of Kansas, its presence has not been proved by actual captures.

These two eliminations leave four species of *Peromyscus* actually known to occur in the state—*P. michiganensis*, on open grounds and in cultivated fields in the eastern half of the state; *P. luteus*, the bleached form, which replaces *michiganensis* in the western part of the state; *P. leucopus*, found in the woods of eastern Kansas; and *P. attwateri*, representing the extension of the Lower Sonoran fauna into southern Kansas.

3. Neotoma campestris Allen.
   Not separable from *Neotoma baileyi*, which has priority of publication. Specimens from western Kansas (the type of *N. campestris* was collected at Pendennis) are slightly paler than those from the eastern part of the state, but there are no other characters to separate them.
4. Geomys breviceps Baird.
   The Fort Riley specimens collected by Doctor Hammond do not seem to be extant, and at present there is no proof of the occurrence of typical *breviceps* in the state.

The foregoing additions and eliminations leave the number of mammals now credited to Kansas as eighty-five.

III.—REMARKS.

Didelphis californica: In my former list* I fell into the error of stating that *D. californicus* [= *D. mesamericana*] may possibly belong to our fauna. Elliott's statement in his Synopsis of North American Mammals, that this species occurs in Oklahoma, together with the occurrence of dark colored opossums in southern Kansas, led me into the error. There is no probability that it will ever be taken either in Kansas or Oklahoma. The dark phase of *D. virginiana* is common throughout the state.

Oryzomys palustris Harlan: An examination of the specimen of Rice-field mouse sent to the National Museum by Capt. B. F. Goss shows that it is of this species, known at present only from the Gulf Coast region. Whether these animals once occurred in Kansas or whether there was an error as to the locality from which the Goss specimens came will probably never be known.

Bassariscus astutus: Professor Knox included the Northern civet cat in his list of Kansas mammals on the authority of Dr. J. A. Allen. Doctor Allen informs me that his information was all second-hand, and not based upon the capture of specimens. Settlers seemed to be familiar with the animal, and Doctor Allen was reasonably sure that the animal occurred in the western part of the state.

Lynx baileyi Merriam (Plateau lynx): The Spotted lynx of southwestern Kansas and western Oklahoma is quite probably of this species. A specimen was secured in Barber county by collectors for the State Agricultural College, but it has not been compared with others that have been identified.

Vulpes fulva macroura (Baird): In *Forest and Stream* (vol. 27, p. 465, January 6, 1887), I find this record, signed N. S. Goss, Topeka, December 27, 1886: "A little over a year ago Mr. Fred Whitney killed a Prairie fox (*Vulpes macrorus* Baird) in Cowley county. He had the animal mounted, and it is now at his home in Meade county. It is the light colored variety spoken of by Professor Baird in his work on mammals (P. R. R. Rept., vol. 8, p. 130), and the first, to my knowledge, captured in the state. Mr. Whitney says that another one has since been killed in the same vicinity." It would be interesting to know whether this specimen owned by Mr. Whitney is still in existence.

Nyctinomus: A specimen of Free-tailed bat was collected at Manhattan by Dr. C. P. Blachly, and sent to Professor Cragin, of

* Trans. Kan. Acad. Sci., vol. XIX, pp. 171-178, 1905.

Washburn, in 1884. Professor Cragin refers to it under the name *Nyctinomus nasutus*. The specimen is probably *Nyctinomus mexicanus*, which occurs over much of Texas. A proper determination of the specimen, which probably remains in the Washburn College museum, will add another species to the Kansas list of mammals.

IS THE GILA MONSTER A POISONOUS REPTILE?

By F. H. Snow, University of Kansas, Lawrence.

IN the desert regions of southern Arizona, southern California, and Sonora, Mexico, a common reptile is the so-called Gila monster, the *Heloderma suspectum* of Cope. Three summers spent in the work of the University of Kansas collecting expeditions to southern Arizona have brought the writer of this paper into somewhat familiar relations with this creature, in regard to whose real character there has been so great a diversity of opinion among non-residents of its natural habitat. In 1886 I had a healthy specimen of the monster sent to me from Arizona by a former student. This specimen I kept in confinement at the University for three years, during which time it subsisted upon a diet of raw eggs. In order to determine whether it was venomous or not I allowed it to bite young kittens, which exhibited no symptoms of having been poisoned, the only effect of the bite being a slight swelling due to the mechanical pressure exerted by the prolonged closing of the powerful jaws of the reptile upon the part attacked.

During the past summer, on July 26, 1906, I had the fortune to be bitten on the ball of the right thumb by a Gila monster, one of a pair which had been captured some two weeks previously and kept in a large box awaiting our departure from camp upon our homeward journey. In the same box were also placed two specimens of a very large frog. Late one afternoon it was observed that one of the frogs had been bitten by one of the Gila monsters. The next morning the bitten frog was dead and its body had shrunken to half its former dimensions. This was the first indication I had observed suggesting that the *Heloderma* might be venomous.

When we broke camp the two Gila monsters were placed in a galvanized-iron water-bucket, over the top of which a towel was tied to prevent the escape of the reptiles. I sat upon the seat with the driver with this bucket in front of me between my feet. The motion of the wagon apparently disturbing the serenity of the reptiles, they soon began to attempt an escape by pushing their heads against the towel. Being fearful that they would accomplish their purpose, whenever the prominence caused by the upward pressure indicated the location of the head of one of the monsters, I would force it down by a rap with the handle of the driver's whip,

or with my spectacle case. At last, becoming a little careless, I used my hand instead of the artificial tools. In one of these careless movements I was struck in the ball of the right thumb by one of the indignant reptiles, receiving six incisions, four of which were of considerable depth, from which the blood flowed in considerable quantities. Fortunately the jaws did not close upon the thumb so that there was no crushing effect produced. I sucked the blood from the wounds until one of my associates, Mr. L. A. Adams, who had some years ago suffered severely from a rattlesnake bite, provided me with a vial of permanganate of potash, which was kept in contact with the wounds for about an hour. No evidence whatever of poisonous effect from this bite was to be detected, and I began to doubt the venomous character of the reptiles, since, notwithstanding the prompt application of the proper remedies, it seemed inevitable that at least some faint trace of the poison should have been left. But unless the Gila monster were in fact a venomous reptile, how could its universal bad reputation be accounted for? I think I may say that, without a single exception, the residents of Arizona and Sonora believe the bite of the *Heloderma* to be a very a dangerous infliction, and several instances were circumstantially related to me of ranchmen and cowboys who had suffered untold agonies and had narrowly escaped death after one of its vicious attacks.

Since my return from the expedition which gave me this unusual experience I have been looking up the literature of the subject, and have had correspondence with some high authorities. Dr. S. Weir Mitchell, of Philadelphia, writes as follows: "This beast bites and lets go, and there is no result. The poison acts when it *chews* on the animal it bites." An article by Doctor Mitchell and Dr. Edward T. Reichert in the *Medical News* (vol. XLII, p. 209) gives the results of careful experiments by injecting the saliva of the Gila monster into pigeons, rabbits, and frogs. The following conclusions are reached:

"That the poison of *Heloderma* causes no local injury. That it arrests the heart in diastole and that the organ afterwards contracts slowly—possibly in rapid *vigor mortis*.

"That the cardiac muscle loses its irritability to stimulate at the time it ceases to beat.

"That the other muscles and the nerves respond readily to irritants.

"That the spinal cord has its power annihilated abruptly and refuses to respond to the most powerful electrical currents."

This article goes on to state that "there remains in our minds no doubt as to the fact that the saliva which drops from the mouth of *Heloderma* when it bites is a very active poison. The briefest examination of the lizard's anatomy shows why it has been with reason suspected to be poisonous and why it poisons with so much difficulty. Unless the teeth are entire, the poison abundant, and the teeth buried in the bitten flesh so as to force it down into contact with the ducts, where they open at the crown of the teeth, it is hard to see how even a drop of the poison could be forced into the wounds. Yet it is certain that small animals may die from the bite, and this may be due to the extraordinary activity of the poison and to the lizard's habit of tenaciously holding fast to what it bites, so as to allow time for a certain amount of absorption."

The latest contribution to the literature of the subject is from the pen of George Wharton James, of Pasadena, Cal., who writes as follows: "Many people will tell you that the *Heloderma* has no poison glands, and that therefore its bite cannot be dangerous. This is a most dangerous illusion. The venom of the *Heloderma* is as poisonous as that of the rattlesnake, as several people who have been bitten have found out to their cost. For many years I have been investigating this subject, and I will make quite clear why some people are bitten by the *Heloderma* without injury and others suffer severely. The venom-glands are situated under the chin, thus being on the lower jaw instead of the upper, as in the case of the rattlesnake. They are modified from glands which correspond to the sublingual glands of mammals. There are four ducts leading out of each gland. These ducts perforate the lower jaw and open in front of the grooved teeth.

"A careful study of the dentition of the *Heloderma* shows that there are several intermediate forms between the unmodified teeth of the reptile and the fully developed poison-fangs. The poison-glands are compound tubular glands, closely resembling the other salivary glands in structure. The peculiarity of their secretion is to be explained by their physiological activity rather than by their structure. So writes my friend, Dr. C. A. Whiting, of the Pacific College of Osteopathy, who has given some time to the study of the teeth and glands of the *Heloderma*. Though their poison teeth are grooved, there is no connection between the poison-glands and the teeth, as in the case of the duct of the rattlesnake. The poison pours out onto the floor of the mouth, between the lips and the gums; that is, into the interior of the bottom jaw. Being below the teeth and not directly communicated to them, the poison

sometimes fails to find its way into a wound. The saliva of the upper jaw is perfectly harmless, as is also the same saliva in the lower jaw; but it must not be forgotten that there is also a deadly venom in the lower jaw, which gets mixed with the saliva.

"As a rule, the Gila monster is lazy and sluggish, and one might play with him for hours and keep him as a pet for years and never see any sign of anger; but let him be angered and then he is dangerous, and the real danger comes when, as he bites, he turns over. With a vicious lunge he seizes the object and at the same moment turns over with lightning-like rapidity. He can hold on with the tenacity of a bulldog, or he can bite so quickly that he snips a piece of flesh out easier than one would pinch off a piece of a cracker. I have seen this action a hundred times, and this is what one must beware of. When the reptile thus bites, holds on, and turns over, the danger of the case is as great as the most dangerons bite of a rattlesnake, for, in this position, if the poison-glands are active, the saliva and poison commingle and flow freely into the teeth, and thus into the wound."

NOTES ON THE BIRDS OF THE BABOQUIVARI MOUNTAINS

During the Months of June and July.

By L. A. Adams, University of Kansas, Lawrence.

WHILE on an entomological collecting trip with Doctor Snow last summer, through his kindness I was permitted to make a collection of bird skins from this locality.

The Baboquivari range is located sixty miles south of Tucson, Ariz. It is about forty miles long and ten miles wide, and extends in a southwesterly direction, the highest point being Baboquivari Peak. It is 10,000 feet above sea-level. The rest of the range is low, and has an elevation of about 5000 feet.

We were camped in a canyon which fairly teemed with insect life. The canyon was well covered with vegetation, and many flowering trees and shrubs, although water was very scarce.

RAPTORES.

1. Aquila chrysætos. Golden Eagle.
   Several eagles were seen soaring above the canyon, and near the summit of the range.
2. Buteo albicaudatus. Sennett's White-tailed Buzzard.
   This buzzard was seen frequently on the lower part of the range.
3. Buteo abbreviatus. Zone-tailed Hawk.
   Rather common at the mouth of the canyon. A Mexican vaquero brought one to me alive. In crossing the desert early in the morning he had seen the hawk sleeping on a mesquit tree and had caught him alive.
4. Accipiter cooperi. Cooper's Hawk.
   Frequently seen in the canyons. One nest was found, the young being full-grown.
5. Falco spaverinus deserticola. Desert Sparrow Hawk.
   They were common on the edge of the canyons, and usually were found near the large tree cactus. They were breeding in holes in these.
6. Megascaps cineraceus.
   They were common; collected several alive by placing an insect net over their hole in oak trees and then hammering on the trees.
7. Micropallas whitneyi. Elf Owl.
   They were common. Would light in trees around the camp, and make their sharp little cry.
8. Bubo virginianus pacificus. Western Horned Owl.
   Saw two in the canyon.
9. Symium occidentalis. Spotted Owl.
   Saw three specimens in the canyon. They were quite tame.

10. Lophortys gambeli. Gambel's Partridge.
    This partridge was very common in the canyons. There were coveys in sight of the camp at about every hour of the day.
11. Zenaidura macrura. Mourning Dove.
    A few were seen.
12. Melopelia leucoptera. White-winged Dove.
    They were very common in the canyons. They have a peculiar soft note which reminds one of an owl's call.
13. Geoccyx californicus. Road-runner, or corn camino, as the Mexicans call them.
    They were very common and very curious. Often when sitting down they would come within six feet of me.
14. Coccygus americanus occidentalis. California Cuckoo.
    Saw two.
15. Dryobates scalaris bandi. Texas Woodpecker.
    Secured only one specimen—saw two.
16. Centurus uropygialis. Gila Woodpecker.
    Were very scarce. Saw a few around the cacti.
17. Aeronautes saxatilis. White-throated Rock Swift.
    These were seen in large flocks up at the heads of the large canyons, where there were large, rocky cliffs.
18. Tyrannus verticalis. Arkansas King Bird.
    Were seen often, but were not as plentiful as some of the smaller species.
19. Pyrocephalus rubinus mexicanus. Vermilion Flycatcher.
    These little beauties were very common in the canyons. They were active and could be seen at all hours of the day catching insects in the trees and up over the mesquite trees.
20. Myriarchus cinerasceus. Ash-throated Flycatcher.
    Often seen.
21. Myriarchus mexicana magister. Arizona Flycatcher.
    Shot three specimens.
22. Myriarchus mexicanus. Mexican Crested Flycatcher.
    Took one specimen.
23. Aphelocoma sieberi arizona. Arizona Pay.
    Were seen at rare intervals at the heads of the deeper canyons; were not plentiful.
24. Corvus corax sumatus. Raven.
    Were common.
25. Lecterus cucullatus. Hooded Oriole.
    Collected one pair; were not common.
26. Papilo fuscusmesolencus. Canyon Towhee.
    Common on the mesquit.
27. Cardinalis superbus. Airzona Cardinal.
    Often seen; secured one pair.
28. Amphispiga bilineata desertuda. Desert Black-throated Finch.
    The Fringillidæ were conspicuous by their absence. The above species and the one mentioned below were the only ones noted. Saw only one pair of the Black-throated sparrow. They were at the mouth of a canyon. Secured the male.

29. Carpodacus cassini. Cassinus Finch.
    Were rather common in the canyon.
30. Laureus ludovicianus excubitorides. White-rumped Shrike.
    Secured one specimen; were not common.
31. Virio bellipusillus. Least Greenlet.
    Common in the canyons.
32. Auroparus flaviceps. Gold Tit.
    Secured the only specimen seen.
33. Lophophaneus wollwecheri. Bridled Titmouse.
    Saw a small number up on the side of a mountain in oak-grown canyon. Judged them to be young ones.
34. Polioptila cœrulia obscura. Western Blue-gray Gnat Catcher.
    Were fairly common in the canyons.
35. Catherpes mexicanus conspersus. Speckled Canyon Wren.
    Secured one specimen on cabin roof. It was the only one seen.
36. Oroscoptes montanus. Sage Thrasher.
    Were common on the lower parts of the mountains.
37. Mimus polyglottus. Mocking-bird.
    Were common in the canyons.

FOOD HABITS OF KANSAS LIZARDS AND BATRACHIANS.

By F. A. Hartman, Wichita.

SINCE a large proportion of the residents of Kansas depend directly upon the products of the soil, any animals which help to preserve these products should be of general interest.

It is recognized that birds and animals which prey upon rodents are of great economic importance. Some of our birds give great assistance to the farmer in the destruction of vast numbers of insects. There are other animals which offer a large factor in this destruction of insects—the reptiles and batrachians. Among the reptiles, the snakes do a great deal of good by feeding on obnoxious rodents and some harm in the robbing of bird nests. The turtle lives upon animal matter, a small part of which consists of live insects; the gopher-turtle eats some vegetable matter. The lizards, of all reptiles, are strictly insectivorous, with a very few exceptions. Neither as loathsome as the snakes, nor as lazy, they are looked upon by most people as harmless. There are some people, however, who fear them as they would a poisonous serpent. One need not be alarmed at sight of any of the Kansas species, for they are all harmless. They are, moreover, very useful. The writer has collected data concerning a few of the more common species.

Holbrookia maculata, a squat, stubby-headed, little fellow, common in sandy regions, especially in the sand-hills sparsely covered with vegetation, lives upon grasshoppers and small beetles. The stomachs of three specimens collected in Graham county contained small beetles and a grasshopper nymph. Sixty of these little fellows were kept in captivity for a few months. They thrived on grasshopper nymphs. Grasshoppers which showed no signs of life when put into the lizard cage were never touched. But as soon as a grasshopper would move one of the lizards would creep quietly up to within an inch or two, turn his head quizzically then suddenly grab the unsuspecting victim and jerk his head from side to side in swallowing it.

There is a brown, medium-sized, sharp-scaled lizard (*Sceloporus undulatus*) that abounds in sandy regions which are covered with cactus, weeds, or scraggy brush. It is found especially along the banks of streams. The examination of five individuals showed that they had eaten grasshoppers (mostly nymphs), ground-beetles, and

leaf-hoppers. These lizards are often found climbing weeds or brush. One of this species was observed clinging to an old sunflower stalk three feet from the ground. In color the lizard mimicked the weed so perfectly that it would escape ordinary notice. It was, no doubt, lurking there for the purpose of catching insects.

The Horned toad (*Phrynosoma cornutum*) examined had eaten a great number of small beetles. This species is not as common in Kansas as it was formerly.

The Glass snake (*Ophisaurus ventralis*), on account of its size, eats as much as some of our snakes. A specimen collected at Lawrence contained three large grasshoppers, one cricket, and one large caterpillar.

The Long-tailed swift (*Cnemidophorus sexlineatus*) can run with such speed that no insect can escape it, except by flight. Even the wary tiger-beetle does not escape. This lizard is very long and slender and runs as quick as a flash. It abounds in grassy, sandy regions. It lives upon grasshoppers, cockroaches, tiger-beetles, and other beetles.

Eumeces obsoletus, the common scink, a large, powerful, smooth-scaled lizard, will tackle animals as large as itself. One of these, kept in captivity with some snakes, attempted to kill a Spreading adder by seizing it by the neck and shaking it. The adder was a foot long. The two were separated after the process had gone on for a time. This specimen was put in a cage with a young Collared lizard (*Crotaphytus collaris*) about three inches long. In a few days the cage was opened and nothing but a few mutilated bones of the smaller lizard were to be found. The scinc had evidently devoured the little fellow and ejected the bones. This species is found under rocks on rocky hillsides. The stomach examined contained large grasshoppers and crickets. One specimen, in addition to this menu, had eaten a large ground-spider.

Eumeces guttulatus, the Blue-tailed scink, in form very much as the above but hardly more than three inches long and of a bluish-black color; hides under rocks. A pretty little fellow, not so repulsive as his close relative, *obsoletus*, he darts among the rocks with such agility that he is caught with great difficulty. The stomach of a single specimen contained a fly, a spider, two leaf-hoppers, and a cricket. Two specimens kept in captivity ate flies and grasshoppers with avidity. Five specimens of *Sceloporus undulatus* were placed in the same cage with them. Three of these were young, varying in size from three-fourths of an inch to an inch and one-half in length. In a few days no trace of the young

ones could be found. A little later one of the old ones was observed to be crawling about merely by the use of his front legs, his hind legs apparently useless from some injury. A few days later a Blue-tailed scink was caught in the act of shaking a *Sceloporus* by the back of the neck. The *Sceloporus* was fully as large as the scink. On examining his hind legs they were found to have been chewed and the bones broken. This shows how aggressive and warlike these little scincs are.

So we find that lizards live upon grasshoppers, crickets, and beetles, all harmful insects, with a possible exception of a few of the beetles.

Among the batrachians we find a greater range of diet, but on the whole it consists of insects.

Amblystoma tigrinum or Mud puppy, the common salamander, is found in ponds, and naturally lives on water insects, although occasional land forms are eaten. Of three larvæ, the stomachs contained, respectively, four, seven and two water-boatmen; in an adult form one ground-beetle was found. In another the stomach was distended with mud.

To the common toad (*Bufo lentiginosus americanus*) we owe a great deal for its vast destruction of insects. They begin their useful work as soon as they leave the tadpole stage, and have no choice in the kind of insects or vermin they eat. They are, in addition, great gormands. Toads eat mostly at night or in the twilight. Street lights are their favorite rendezvous. Great numbers often congregate in these places. In Kansas City fifty toads were counted under one light at one time. They will run in numbers from two to as many dozen under a single light. The young ones are to be found in swampy places or near ponds. Three young specimens collected in Graham county, about three-fourths of an inch in length, contained as follows: Twelve ants and twelve small beetles, twenty-eight ants and three small beetles, twenty ants and one beetle. A specimen seven-sixteenths of an inch long contained nine snapping-beetles. A specimen one and four-tenths inches long contained four medium-sized ground-beetles. Two adults had eaten as follows: The first, one large *Scolopendra*, four snout-beetles, one moth, and one ground-beetle; the second, ten May-beetles, three snout-beetles, and two ground-beetles. Spiders and phasmids have also been found in the stomach of this species.

A number of toads were collected from three lights at Kansas City at nine o'clock P. M. on June 9. The toads had not been away from their retreats more than an hour or two. From among this

number eleven were taken at random, and the contents of their stomachs examined. The following kinds of insects were found: Cincindelidæ, ground-beetles, crickets, snapping-beetles, leaf-hoppers, ants, *Belostoma*, *Lachnosterna*, grasshoppers, tumblebugs, Lampyridæ, and carrion beetles. The specimen that had had the largest meal contained sixty beetles, three leaf-hoppers, and three ants. No telling how much would have been eaten in a few more hours.

Bufo cognatus, a smaller species, colored with a brighter pattern, and having diverging occipital crests, has practically the same food habits. The specimens examined contained snout-beetles and dung-beetles.

Among the tailless batrachians one of the most interesting is the little cricket-frog, *Acris gryllus*. They abound in swamp streams and roadside pools. They are of a dark color, and many of them are marked on the back by a rusty-red triangle. Out of seven specimens examined from different parts of the state, the following were taken: Ants, a caterpillar, lady-bugs, snapping-beetles, a spider, one small crayfish, and small beetles unidentified. For their size, they eat a fair quantity of insects, and, on account of their number, in some localities, they help considerably in insect destruction. Several specimens of *Hyla versicolor*, the common tree-frog, failed to show any evidence of a meal. A specimen collected by Mr. Crevecœur at Onaga contained one small cricket. It may be that some of these specimens had not had a chance to eat, because they were collected in the spring, before insects were very active. These small frogs live amongst vegetation, and undoubtedly do some good.

Belonging to the family Hylidæ is another rather common frog, the Striped bush-frog, *Chorophilus triseriatus*, seldom seen in the summer, but common about pools of water in the spawning season. This is a small frog, about the size of a cricket-frog, and has three prominent stripes running down the back. Four very young specimens had eaten, as shown by their stomach contents, algæ and ants. Out of four adults collected in the spawning season, two had eaten nothing, while the other two had eaten a spider apiece. These frogs during the summer probably live upon the same kind of food as their kin, the *Hyla*, because they live in the same habitats.

The large Green bullfrog (*Rana catesbiana*) is quite an eater at times. From the stomach of one of these a full-grown sparrow was taken. Young specimens of these species contained remains of water-beetles and ground-beetles. A single specimen of *Rana*

areolata circulosa, collected on the Wakarusa bottoms near Lawrence, contained two good-sized crayfish. These bottoms afford a place for a good many crayfish to dig their burrows. Evidently this frog had been living at their expense. When caught he had taken refuge in a crayfish hole. The markings are very striking, and distinguish it easily from the common spotted frog. It is covered with large, black, circular blotches. It seems to be quite rare in Kansas.

The commonest of all frogs, *Rana virescens brachycephala*, is probably very useful as an insect destroyer. However it does not equal the common toad. The stomachs of this species which were examined yielded the following miscellaneous food materials: Beetles, grasshoppers, crickets, a worm, water-snails, myriapods, and one solpugid. Both the young and adults were examined. In quantity of material they fall far below the toad. The tadpoles of both toads and frogs live upon vegetable matter.

Among the lizards and batrachians the toad stands far above any other member in the number and quantity of insects destroyed. On the other hand, taking the groups as a whole, the batrachians are outclassed by the lizards as insect destroyers. Vast numbers are destroyed by them every summer. One cannot really estimate the value of these small animals.

CERTAIN CONDITIONS TO BE MET BY THE INSECT COLLECTOR, PARTICULARLY THE AMATEUR.

By Elbert S. Tucker, Museum Assistant in Systematic Entomology, University of Kansas, Lawrence.

ALL phases of work with insects hold a fascination to the true entomologist. The more difficult the part the more absorbing it becomes, but the most enjoyable feature lies in the collecting. Only a simple outfit is needed for collecting purposes—a net and a couple of poison bottles are usually sufficient—though a few other things which can be carried without trouble will prove useful at times. Provided with such light but effective equipment, what pleasure awaits the collector who is free to rove as he wills through fields and woodland, along streams and shores, or on mountain or plain, in search of coveted insect specimens. While some places are to be preferred above others in yielding results, yet, for such a matter, multitudes of different forms which appear during the warm months of the year generally abound close to one's own home, whether situated in town or country. Therefore, the collector can find much to inteaest him, ready at hand in most cases, wherever he happens to be.

Many persons who cherish a fondness for nature study are busily engaged by day in ordinary vocations, but still no excuse should be made for want of time to collect and study insects, to some extent, if desired, when holidays, vacations and various odd periods of leisure allow valuable opportunities, even if only a few minutes at a time. Besides, entomology as a field for investigation has an advantage over other branches of natural history on account of the great number of insects which fly at night, thus permitting the collection of specimens after daylight has fled. This privilege, which is most munificently afforded on summer evenings, proffers a delightful as well as instructive diversion from one's daily work.

The constant accumulation of specimens, little by little perhaps, here and there, by day or by night collecting, will soon reach proportions of which the amateur collector may justly be proud. In spite of all difficulties to be encountered in collecting, the amateur becomes assured that ample returns will compensate nearly every effort expended. Then an interesting display of material will invite study, provided the collector has exercised good judgment and practice in his efforts. His work, however, is not perfect without

careful and proper mounting of specimens, nor complete without explicit data.

Every definite locality that is given for the capture of a species is important in defining the extent of territory in which that species occurs, and such references, however local they may sometimes be, assist, often appreciably, in extending our knowledge of geographical distribution and in fixing the limits of their life zones. Next in value to the record of the locality in which an insect was taken was the date of capture; without these two most important particulars, the specimens are almost worthless. On the other hand, the records of further particulars learned from observation and experience, will render a collector's attainment of high scientific value.

The designation of captures made at night from those made in daytime seldom receives adequate attention, since far too little heed is given to the use of distinctive pin labels on which the data should be written or printed. The addition of the words "twilight," "at night," and "at electric light," on day labels, will answer most requirements for night collecting.

The triumph that affords the greatest satisfaction in the accomplishment of something worthy of commendation is achieved in the face of difficulties. Circumstances are frequently contrary to one's wishes; still a person need not be dismayed by interruptions nor deterred from a worthy purpose by unavoidable delays. Collecting can go on even if the work of determination lags. Portions of my own collections have been held fully fifteen years before the specimens were thoroughly identified.

A considerable extent of the systematic work in entomology lies beyond the skill, if not the time and facilities, of even the most experienced collector. But such difficulties, which especially face the amateur, are largely overcome through the generous assistance of specialists, who generally desire, in fact ofttimes request, selected material for research study. By taking advantages of these privileges, undetermined material may finally receive satisfactory attention. Without such recourse, the collector would be seriously hampered and likely refuse to collect or at least to save specimens which he could not readily identify himself within the limitation of his own resources. On account of the immense number of different forms of insect life, the specific or individual recognition of every kind of insect surpasses the ability of any one person. Even specialization in a restricted group alone entails slow progress towards perfect identification of species. The interests of entomo-

logical science require the furtherance of mutual relations between collector and research worker, since one needs the other's help. In exchange for his duplicate specimens sent to one or more authorities, the collector learns the names of the species, or perhaps a greater part of them, when reported upon, which service, together with his collecting records, places him in possession of a fund of scientific information that might ultimately be embodied in respectable lists for publication.

ADDITIONS TO THE LIST OF KANSAS COLEOPTERA FOR 1906.

By W. KNAUS, McPherson, Kan.

THE following list of sixty species of Kansas Coleoptera have, so far as I know, never been published in any of the various Kansas lists. Those species followed by the names, Leconte, Horn and Smith are records from Kansas by these authors in their monographic treatment of the various families and genera of Coleoptera, but I believe have not been taken by local collectors.

The species from Douglas county are from the records of Prof. F. H. Snow; those from Onaga have been reported by F. F. Crevecœur; and the other localities, with one or two exceptions, refer to my own collecting.

In the list for 1905, published in part I of volume XX, a few errors occur, as follows: *Bostrychus cornutus* is probably European; *Cartodera argus* Fall should be *C. argus* Reitt; *Oligomerus alternatus* Lec. should be *O. alternans; Petalium seriatum* Lec. should be *P. seriatum* Fall; *Catorama confusus* should read *C. confusum*, and *C. nigritulum* Fall should be *C. nigritulum* Lec.

Thanks are due Mr. H. C. Fall, of Pasadena, Cal., for many of the determinations.

25*d* Cicindela 10-notata Say. Douglas county, 1 specimen.
Notiophilus novemstriatus Lec. Benedict, Wilson county; 1 specimen.
218 Pasimichus punctulatus Hald. Onaga; occurs occasionally.
293 Ardistomis puncticollis Putz. Galena; collected by Ebb Crum.
9252 Bembidium postfasciatum Ham. Douglas county.
robusticolle Hayw.
547 Pterostichus relictus Newm. Douglas county.
567 convexicollis Say. Onaga.
617 Evarthrus heros Say. Wilson county.
623 Amara avida Say. Wilson county.
735 Badister elegans Lec. Douglas county.
800*a* Platynus subsericeus Lec. (Leconte).
922 Callida decora Fab. Douglas county.
927 Philophuga amœna Lec. Douglas county.
1068 Discoderus impotens Lec. Salina.
1073 Stenomorphus rufipes Lec. McPherson and Topeka.
Aleochara kansana Csy. Douglas county.
Aleochara ellipsicollis Csy. Douglas county.
2093 Acylophorus pratensis Lec. (Leconte).
Trichiusa atra Csy. McPherson; several specimens.
Gyrohypnus melanops Csy.

2426 Stenus dispar Csy. Topeka.
2895 Triga picipennis Lec. (Leconte).
Scymnus bisignatus. Medora; 1 specimen.
3992 Eucinetus morio Lec. Onaga.
4376 Limonius ornatipennis Lec. Douglas county.
4662 Chrysobothris æneola Lec. (Horn).
4720 Agrilus arcuatus Say (Horn).
4720 torquatus Lec., var. (Horn).
4745 imbellis Cr. Medora; 1 specimen.
5202 Hydnocera pedalis Lec. Belvidere; one specimen.
Catorama triviale Fall. McPherson; one specimen, taken in June by sweping grass.
borælе Lec. Medora; one specimen, by sweeping grass.
5719 Diplotaxis truncatula Lec. (Horn).
5735 innoxia Lec. (Horn).
5837 Anomola cavifrons Lec. Rooks county, Gove county, and westward.
ludoviciana Sch. Central Kansas, eastward.
6005 Phymatodes decussatus Lec. Wilson county.
6008 Callidium antennatum Newm. Central Kansas; imported in pine lumber.
6398 Goes debilis Lec. Leavenworth county.
6453 Pogonocherus mixtus Hald. (Leconte).
Saxinis knausii Sch. Belvidere and Englewood.
6601 Chlamys plicata Fab. Central Kansas.
6616 Crytocephalus binominis Newm. (Leconte).
6844 Phyllodecta vulgatissima Linn. Central Kansas.
Epitrax numeralis Drury. McPherson; May and June; several specimens, by sweeping grass and plants.
7073 Odontota collaris Say. Onaga.
7719 Salpingus tibialis Lec. (Leconte).
Mordellistena, n. sp. One specimen; McPherson; June.
Xylophilus, n. sp. One specimen; Belvidere; June.
8013 Nomaspis parvula Hald. (Horn).
8378 Apion cribicolle Lec. (Smith).
8413 erternum Smith (Smith).
8416 extensum Smith (Smith).
8422 confertum Smith (Smith).
8424 xnigrum Hbst. (Smith).
8574 Endalus punctatus Lec. Medora; one specimen; June; sweeping grass.
Onychobarris n. sp., near millepora Csy. Belvidere.
9038 Phlœophagus minor Horn. One specimen; Onaga.

V.

MISCELLANEOUS PAPERS.

"Noise: its Relation to Health, Disease, and Longevity."
By J. M. McWharf, M. D., Ottawa.

"Dances of the Jemez Pueblo Indians."
By Albert B. Reagan, Mora, Wash.

"Climatology of Kansas."
By T. B. Jennings, Weather Bureau, Topeka.

"Nature Photography in Kansas—Work of Mr. and Miss McColm."
By Grace R. Meeker, Ottawa.

"Gaging of Sewage Flow at Lawrence, Kan."
By Prof. W. C. Hoad and A. H. Mann, University of Kansas.

"The Accuracy of a Modern Balance and Set of Weights."
By H. I. Woods and Alice K. McFarland.

"Change in the Climate of Kansas."
By F. H. Snow, University of Kansas, Lawrence.

NOISE: ITS RELATION TO HEALTH, DISEASE, AND LONGEVITY.

By J. M. McWharf, M. D., Ottawa.

THIS question has never received a fair consideration at the hands of science nor of the medical profession; we are therefore unable to give as complete status of things as might be hoped for or desired.

The gravity of the question necessarily demands a thorough, scientific investigation of all points pertaining thereto. In our mad rush for wealth, we forget that health, life, in fact, everything, must be sacrificed. Are we to be classed with the "heathen Chinee," the man who has educated himself up to a condition of stolid indifference at the sacrifice of a human life? He looks at his brother as he sinks beneath the wave and never exerts a muscle nor expresses a word of sorrow or regret; the environments do not touch a chord of sympathy, and in all probability are never recalled.

Not many years ago a poor, deluded, foolish fellow conceived the idea that he preferred to live in New York or not to exist at all. The noise of the great city he could not endure, especially ths earsplitting noise produced by the bells of a neighboring church; he therefore sought relief by committing suicide. This is an individual case, and yet there are thousands of cases to-day where people are made ill, or are committing slow but sure suicide, as a result of useless noises.

Noise must be classed as a great factor or element as a non-producer of health. This being true, it is of necessity important, from a medical standpoint. Every scientific man, and especially every medical man, should have a word to say and a duty to perform along this line. If we study this question from a physiological standpoint, we are forced to admit that rest is essential to health and longevity. This being true, over or persistent stimulation of an organ or a set of organs must necessarily be pathogenic. The greater the tension of the machinery in action, the less the durability. Herbert Spencer, it is said, used a mechanical contrivance and plugged up the auditory canals, thus securing relief from noise. Such action is not commendable, yet we are forced to admit that the relief would be a happy combination of circumstances.

There may be, stored away in the brain of some aurist of to-day, a healthy and practical method whereby one could, at will, shut out all unwelcome sound; such inventive genius would be a great benefactor to humanity. Should we consider our question sociologically, certain factors confront us. There is an unrecognized duty, as regards noise, that rests upon a physiological and esthetic basis. Perfection in any organization demands delicacy and accuracy of response to a physiological stimulus; whatever retards or prevents this must be antagonistic to the welfare of society and to its progress. This is a brutal, noise-making period, prolific of results. The ceaseless bruising of the mind and destruction of the nervous system tend to produce disease and shorten the natural duration of life. The auditory or nervous mechanism with which it is connected must be blunted in sensitiveness, crushed, and stupefied, or a pathological result will follow.

Imperatively the people are divisible into two classes: First, those whose nervous systems and minds are becoming mechanicalized, anesthetized, and brutalized; second, those who, having failed to kill sense and mentality, have developed diseased reaction.

From this hypothesis we arrive at the following conclusion: That noise may be considered an agency which produces one of two conditions—a sickly or a savage individual. Civilization to-day is bearing upon its bosom a self-poison, the result of which will be its own downfall; there will be a loss of refinement and delicacy of the senses, and this will produce a retrograde movement toward barbarism. Should this condition prevail with us, then of a necessity we are becoming neurotic, hysteric, and neuresthenic. Society will then progress toward a crowd of the mentally stupid or the hyperesthetically morbid. Social amusement to-day is but a game of battering and spurring, jaded and blunted senses, or at least ministering to sense diseases.

The medical profession, taken in its narrowest sense, is bound to reduce the amount of noise-making, for noise not only engenders disease, but prevents its cure and hastens to a final termination. Statistics corroborate this statement. It is authentically stated that in the city of Philadelphia there are upward of 4000 needless deaths, and 8000 were made ill each year from purely unnecessary noises. What may be true of Philadelphia is an axiom in regard to other large cities; while it is impossible to secure exact data upon the points in question, there is a degree of certainty in the hypothesis taken. Many of the sick are kept in their homes, while others are cared for in hospitals, that, unfortunately, are too often

located in the most densely populated portions of the city; in either case, noise may be the disturbing factor. The sick must seek seclusion, and quiet should be their environment. Every intelligent physician is cognizant of the fact that quiet is essential in the sick-room. He fully understands that noise has been the baneful influence — the destructive factor — many times hindering his efforts to cure.

We are a reckless people in the production of unnecessary noise. Not satisfied with what can be accomplished during the day, this disturbance is kept up long into the night, in many cases during the entire sleeping hours. Night is frequently made hideous with drunken brawls, whistles of locomotive-engines, street-car whistles or bells, laying of railway-tracks, the paving of streets, etc. In many instances this work is necessary only for the advantage and profit of mercenary corporations, and yet the authorities have no power, and, should they possess it, they will not make an effort to repress the evil. Being a freedom-loving people, we submit to this tyrannical master who knows no race nor condition; the monotonous grinding goes on; one or a comparatively few are benefited, while a thousand are tortured and outraged by this bedlam. It is claimed that ten per cent. of the people go to church; then why annoy the other ninety per cent. with the sound of bells which are rung only for notification? Has the ninety per cent. no rights that should be respected? Have not the sick rights that should be recognized? The milkman, the cartman, the pedler, the hawker, the ragman, and, last but not least, the girl who splits her throat warbling, all bawl and howl with such a degree of hideousness that they can be heard from one to several blocks away. Do you wonder that the nervous system is broken and the individual driven to desperation or self-destruction? We are a fast people, living in a fast age, rushing forward in mad frenzy toward dissolution or a premature old age.

Noises should be classified as necessary, partially necessary, and totally superfluous. If considered upon the plan of exclusion of the latter, we would get rid of at least seventy-five per cent. of all noises. This work is in harmony with an advanced public welfare, and we should have an organization to be known as "The Association for the Public Good," the duty of which is to see that all loafling rowdies, howlers, whistle-blowers, bell-ringers and song-warblers be hushed.

The block, cobblestone and brick pavements are noise producers; also a prolific source for the culture of filth and disease germs;

they should be abandoned and in their stead the asphalt pavement, which can be flushed and kept sanitary, should be used.

The character and civilization of any country are determined by the amount of unnecessary noise it endures. If noise is considered only as a discomfort, and not antagonistic to our physical well-being, we need not expect any action to be taken as a preventive, but just as soon as this nuisance is unmasked by the searchlight of a perfect investigation, prompt action will be taken, and it will cease to be a menace to health, disease, and longevity.

DANCES OF THE JEMEZ PUEBLO INDIANS.

By Albert B. Reagan, Mora, Wash.

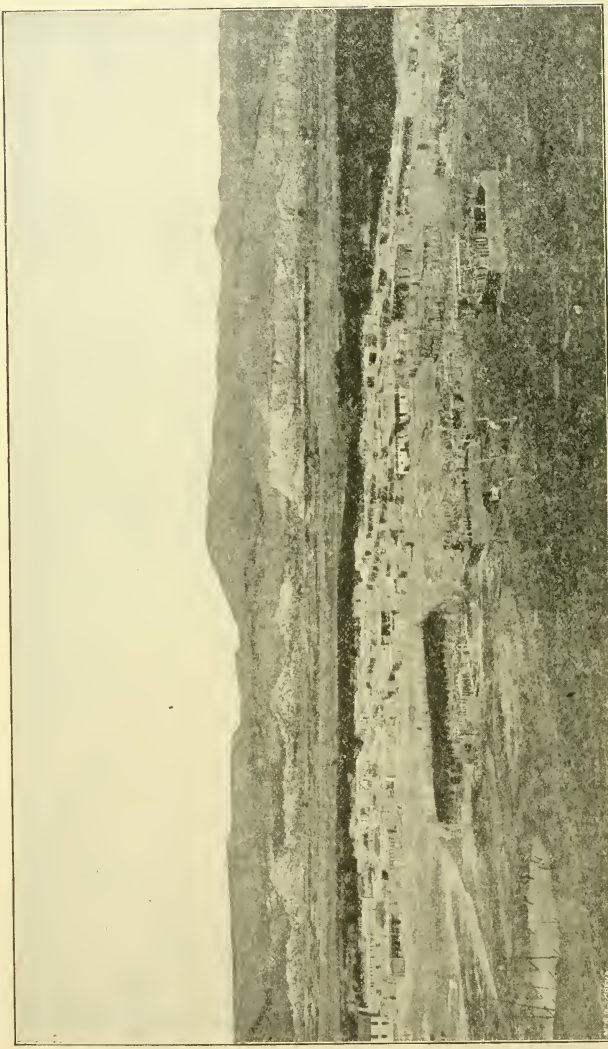
THE Jemez pueblo Indians are a semicivilized tribe residing in the northwestern part of New Mexico, about sixty miles southwest of Santa Fe and fifty miles north of Albuquerque. They, like their pueblo neighbors, differ in many characteristics from the nomadic tribes, devoting their attention principally to the cultivation of the soil and the raising of stock. They live in houses built of stone or sun-dried brick.

They have a division of labor, the women doing the house work, the men the work in the fields.

Their civilization dates back to a period anterior to the arrival of the Spaniards; and, owing to their isolation and manner of living, they still retain their ancient language, customs, superstitions, and religion, though all of them talk the Mexican language and are adherents of the holy Roman Catholic church.

These Indians are religious in the extreme; every move, every voluntary act, even the smoking of a cigarette, is performed with some religious end in view. They are worshipers of nature, and they endow each object with its counterpart spirit. The sun, moon, stars, clouds, lightning, rainbow and snake are their chief objects of worship. Symbols of these objects of worship are painted on their dancing regalia and in their dwellings, secret apartments, and religious halls. In front of these symbols they pray and sprinkle corn-pollen or meal, usually morning, noon, and evening, they believing that the symbols have the power to carry the prayers of the children of men to the deities they represent.

Halls are built by these people for the purpose of worship, and many of their dwellings have secret religious (dark) rooms in them; besides, many of the houses have blind closets. In the latter the things of a religious character, which the Jemez does not desire the public to see, are stored away and sealed up till needed again in religious worship. In the dark room are the altars, the idols, and many symbolic drawings and paintings. In this room also, lying beneath the sacred symbols, are bunches of the downy eagle feathers, so sacred to the aborigines of the region. Among these bunches of feathers, bowls of sacred dust—corn pollen and meal—are setting. In this room the "family worship" is carried on, and in it the oldest woman of the family sprinkles the sacred



JEMNEZ PUEBLO AS IT IS TO-DAY.

dust three times a day in front of the symbols and idols, the latter being crude figures of men and animals, carved out of wood or stone.

The halls of worship are large, rectangular, flat-roofed buildings, the inside walls of which are decorated with symbolic paintings of the greater and lesser deities of the Jemez tribe. Before these sacred emblems the "cacique," or sun priest, sprinkles the sacred dust, and prays both at the beginning and at the close of any special ceremony. In front of these same paintings the dancers and clowns train themselves for special occasions, and from their presence they emerge from the building to dance and perform before the public in the plaza, and to their presence they return at the close of the public ceremony, to be sprinkled with the sacred meal and to receive the blessings of the gods.

While United States Indian farmer at Jemez, in 1899 and 1900, I visited each of the halls of worship (estufas) at will, being with the Indians in them as many as six nights in the week. I also examined the blind closets and secret rooms in their dwellings, and visited their open-air performances held during my sojourn there. Thus was I enabled to see many things of interest. Among these were their dances. Observations on these I give below.

THE MASKED DANCE.

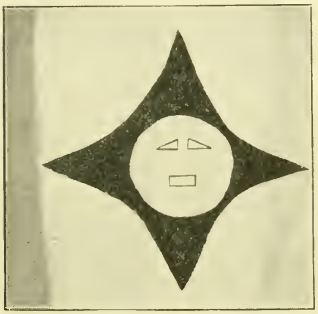
One morning soon after I went to Jemez an "Ahoo, ahoo, ahoo, ahoo, ahoo," broke the stillness of the morning air. A masked sun-dance was commencing. The "Ahoo, ahoo, ahoo," grew louder and louder and became a more basic, hideous sound, as sixteen strange-looking creatures issued, one after another, from the passageway in the roof of the rectangular sun-house. They were the clowns that, according to the Jemez belief, represent the principal gods, the sun, the moon, the morning star, and the evening star, on all special religious occasions. All of these clowns were gaudily dressed. All had conspicuous head ornaments, and all wore circular masks some eight inches in diameter. On these were painted the gods they respectively represented, together with paintings of clouds, of lightnings, and of snakes.

The arms of these clowns were naked. They wore leggings and moccasins tinged in red. Their yellow-painted bodies were wrapped in richly colored blankets or robes, on which were embroidered, in characteristic colors, figures of the sun, of the moon, of the great stars, of the good and evil snakes, of the rainbow in the west and the rainbow in the east, and of the four pillars of clouds—the steps from earth to heaven—all making a fantastic display.

The head ornament usually consisted of eagle feathers so arranged on a buckskin covering as to represent the spread tail of a bird with reverse side presented to the front. Back of this fan of feathers were paintings of the greater gods, whose outlines were formed with tiny images, beads of turquoise, and shells of various kinds.

The masks, with respect to the figures painted on them, were four of a kind. The symbol which the wearer represented occupied the central position on the mask. These central figures consisted of a disk surrounded by concentric bands in the sun and moon drawings and by points in the star symbols. The disks of all the figures were red, except those of the moon, which were white. The inner band of the sun was black, the outer was composed of rays of red alternating with outer spaces of yellow. From this outer band there projected darts in red; one to the right, one to the left, one toward the heavens above, and one toward the earth beneath. The white disk of the moon was surrounded by a wide yellow ring. From it four groups of peculiar-looking figures projected, one toward each of the four cardinal points when the mask is laid flat on the ground, with one of the groups extending in a cardinal direction. The Jemez Indians suppose that these groups represent the rays of the moon. Each group consisted of two yellow figures inclined at a small angle from the perpendicular and from each other. Each of these terminated at its outer end in a blue disk. The whole looked much like a half-burned cigar, the blue disk representing the ashy end. The stars were four-pointed. The points of the morning star were black, those of the evening star yellow. The disks of all the central symbols were god faces. The eyes were triangular in shape, the mouth rectangular. Both the eyes and the mouth were painted black. The outer figures on the masks were at the right and at the left of the central emblem. The drawings on the one side were the counterparts of those on the other. The four pillars of clouds, painted black, projected out and extended as a succession of steps along the rim of the mask almost from its lower part, as the mask is worn, to its upper part. From these cloud-pillars, or "steps from earth to heaven," as the Jemez believe them to be, four figures, painted in striking and characteristic colors, extend, one from each cloud projection in toward the controlling symbol. The upper figurere presented the bolt lightning; the next lower a red, zigzag-bodied snake, having a blue head from which a horn curved backwards like a goat's horn. This figure is the emblem of evil. It is the Indian devil, Sawah. The

third from the top was a sinuously curved yellow figure which terminated in three green buds. It was drawn to represent the flash or heat-lightning, which the Jemez believe is the god of bloom. The lower figure was zigzag, a blue-bodied snake, having a green head, with horn turning backwards, similar to that of the red snake above described. This snake is the representative of good. It is considered by the Indians as the producer of rain, as being the genius of the watercourses.



The "Morning Star" in one of the dwellings at Jemez. (By permission of the Bureau of Ethnology.)

The dancing skirt and belt.

As soon as the god representatives had descended from the roof of the estufa they began to dance and crow-hop about, keeping up their ear-grating "ahooing" all the time. This they did for about ten minutes. Then they began to march around the village, if march it can be called. They advanced in a long, drawn-out column. Some crow-hopped it along; some jumped like a man, others like a frog; some walked with a cane, mimicking an old man; the cane was tri-colored in red, yellow, and green. Some, leaning forward on short canes, walked on all fours. Others strutted about like a turkey-gobbler. Occasionally all stopped a moment to pose. In this act they usually stood half erect, threw their hips backwards, contorted their bodies, and brought their heads in a position so that the circular mask presented a full front to the god of day, or to his place of rising. At the same time they prolonged the "ahooing" and gave it an emphatic accent. In this manner did they march and pose till they had encircled the whole village and

returned to the public square in front of the estufa. From that time on they mingled with the populace in the streets and plaza, feasted, danced, crow-hopped, or posed, as the "spirit moved" each individual or the whole group collectively till the close of the dance.

Soon after the god-clowns had begun their march around the village twelve men, dressed or undressed, as each one's fancy dictated, their faces whitened with paint, issued from the estufa, and began to chant a rude rhythmic shouting in the minor key; the time was beaten with a single stick on a drum made from a hollow log. These musicians advanced in a body through the plaza, keeping time with their feet and gesticulating in a manner intended to convey the meaning of their song.

As soon as the musicians were far enough from the estufa to give room, the dancers issued from that house and formed a fantastic procession in double column, two men abreast, then two women, and so alternating till the procession was completed. The men stamped and the squaws tripped lightly, but all were keeping time. They presented a weird appearance, tricked out in their gaudy apparel and ornamented with flashy trinkets. The hair of the men was worn loosely; tufts of feathers fluttered over their foreheads; while around their necks and dangling over their naked chests were strings of shell beads, turquoises, bright pebbles, feldspar, obsidian—anything, in short, that glitters and shines. Fastened about the waist and reaching nearly to the knee, a rude kilt-like garment, dancing skirt made of buckskin or sacking, hung and flapped. It was ornamented with an embroidery of red and black threads. Below the knee, garters of buckskin, stained red, yellow, and blue, formed a fringe, to which were attached tortoise-shells and rattles. The ankles were encased with strips of black and white fur. From the waist a fox skin hung, fastened at the back and reaching almost as low as the heel. Each man carried a tuft of hawk's feathers in his left hand, while the right grasped a rattle fashioned from a gourd, partly filled with pebbles. The women wore their ordinary black dress, trimmed, however, with a profusion of necklaces, strings of beads, silver badges, wristbands, and ear pendents, while in each hand was borne an ear of corn, which was wagged from side to side. Both the men and women wore masks and striking head-dresses. The masks were heart-shaped, with the exception of the base, which was a straight line. They were made of buckskin, were painted blue or green, and, like the circular masks, had triangular holes cut in them for the eyes and a rectangular hole for the mouth. The head-dresses consisted of a

board-like piece of wood about fifteen inches long and eight inches wide. One end of it was carved out, in arch shape, so as to fit the head transversely just in front of the ears. The other end was trimmed in what resembled a triple turret, squarely notched. This head-piece was painted green and decorated in symbolic figures in red and yellow. White feathers fluttered from each of the three turret-like projections. This peculiar head-gear was held in place by strips of buckskin attached at the center of the hollowed-out arch and knotted about meshes of the dark, streaming hair, and also by a cord passing beneath the chin from the ends of the board at the foot of the arch.

Just as these dancers had formed in column for dancing, attention was suddenly attracted toward the passageway of the estufa, whence were issuing a dozen or more strange-looking beings. They were the "funny men." They did not walk into the plaza, neither did they dance into it, but rather tumbled into it, running, hopping, stumbling, cutting capers, like a troupe of ill-trained clowns. In fact, in their clumsy way, they imitated or acted out almost every silly performance known to the clown profession. And the lookers-on enjoyed their tricks and pranks immensely, to use the common phrase; they hailed the clumsy attempts at a joke and the coarse sallies of wit with shrieks of laughter. These "funny men" were attired only in breech-cloth; their bodies were daubed in transverse rings or bands of black and white; and their heads were decorated with corn husks instead of feathers. They were, indeed, "funny men" in appearance as well as in action.

While the clowns was thus performing, the column dancers moved about the whole plaza in a forward movement, the men gravely stamping, the women gracefully tripping. When the entire plaza was completed in this processional dance, the "couples" separated and changed places, all turning and facing each other, suggesting by their movements the flexures of a closely folded ribbon. The "couples" then reformed, the double rank strung out as before, tramping in a wide circle to the rhythm and measure of the monotonous music. The faces were now reversed, and they danced in double column back to the starting-point. A rest was then taken.

The very moment that the dancing ceased, the "funny men," who had been resting for a few minutes, resumed their performing with increased vigor. One funny man climbed a tree backwards. Another snatched a millstone and slab from the grinding box in a house and, rushing to the plaza, commenced grinding sand upon

it, singing in mimicry all the while, and putting handfuls of sand in his mouth now and then. He was in this manner mimicking a squaw grinding meal. Four or five more played a farce in representation of the immorality of the place. Another got the skull of an elk and began to beat it, while several of his fellows danced the double-column dance. As they were thus dancing, another one of the order walked stately in a reverent manner to the column and, as he prayed in jest, sprinkled each dancer with sand and ashes. In this manner did he mimic the sun priest sprinkling the dancers with sacred corn pollen in the estufa before they issued from it to dance in the plaza. Just as the mock dancers were dispersing, a funny man tumbled out of a house with an ear of corn in his hand. Reaching the dancing area, he began to gnaw the ear like a dog does a bone. Instantly another dog-acting man began to snarl and growl, and finally sprang upon the bone-gnawer in a manner that would make any stranger expect to see a genuine dog fight. At that moment the attention of every one was attracted from the pretended dog fight by the shrieks of the girls and women. The clowns were making sallies on them. Some of the younger men of the fraternity were trying to embrace the older women; some of the older men the young girls. This teasing of the women lasted for a minute only. Then all the "funny men," acting upon a previous plan, tumbled and rolled over each other towards where the war captain was standing, until they were within a yard or so of him. Springing to their feet they seized him and carried him on their shoulders to the center of the public square. Reaching it, they placed him on a piece of buckskin and, in a body, demanded a speech, the chief "funny man" introducing him to the motley multitude in these words: "Here is our war-captain. He is a brave man. He has killed the bear in his hole. He has been the hero in many a religious hunt. He has captured the eagle alive and unhurt. Years ago he fought the Navajos and drove them even to their hogans in their own land. Aye, he is brave! He would fight even the demons of the land of fogs and storms. He is a brave man. Hear him."

Tiring of being thus made fun of, the war-captain turned a flashing eye upon his tormentors and said: "You shall have a speech." Then without further ceremony he proceeded; "This earth is flat and round like a pancake and is known to possess four places of habitation, situated one above another. Each has for its roof the floor of the apartment above it, except this one, which has the sky. A long, long while ago our people lived in the apartment

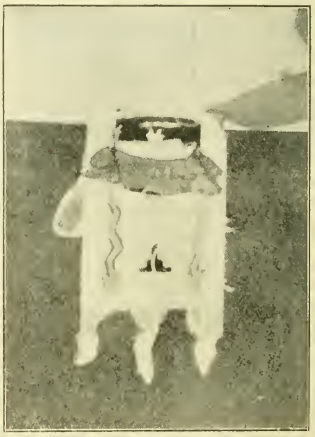
beneath this one. For a long time they lived there. Finally one day a man saw a hole which led up through the roof to this world. He crawled up through it and all the people followed him. The mouth of the hole being in the far, far north, a council was called. At this meeting the 'principals' decided to move toward the noonday sun. Said they: 'The sun warmed the place from which we came; therefore, by moving towards it this earth must become warmer.' So they began their march over mountains of ice and snow toward the boiling ocean. For a long, long time they journeyed; but the land of sunshine was not yet reached. On, on they marched till their food supply became scanty and their blankets became worn out. Then one by one they died of cold and hunger. For a while those who survived kept up courage even under the adverse conditions, and continued their onward march. At last, however, their numbers being so depleted, they became despondent and wished all to die. At this juncture the mother god, the moon, prayed to her husband, the sun, to save the remnant of men, their children. So the sun took one of the survivors of our people, painted his body in transverse black and white bands, decorated his head with corn husks, and suspended an eagle feather behind each ear. As soon as thus painted and decorated this man became a 'funny man,' and began to dance, cut capers, and make grimaces. So interested did the people become in his performing that they forgot their sorrows and became glad. They then resumed their journey, which they continued till they reached the confluences of the Rio Grande.

"Here in this valley they ceased their wandering and took up places of abode. Being few in numbers and not being trained in the arts of war and defense, they were afraid of the savage tribes, the Comanches, Apaches, and Navajos, that dwelt in the region. So they established their places of habitation in narrow canyons, along cliffs, and in caves. In these they lived a great, great while, subsisting on the grain they raised in their fields and on the game so plentiful in the country at that time. Then the savage hordes began to make inroads into the territory. They killed all the game, or, by their presence, it was made unsafe to hunt. They took the fields one by one. They drove the people to the cliffs and caves; and then either captured these strongholds by storm or starved the people until they came out of their own accord and gave themselves over to be slaughtered or to be enslaved. Only a few places still held out, and these were reduced to such straits

that their capture, followed by the massacre of the prisoners, was daily expected. Certain was their annihilation.

"Again the mother god prayed to the sun to save their children, and a second time the great father came to the rescue. At this time he placed among them a 'knowing man,' whose name is Montezuma.

The Pueblo dancer (back view.)



The head ornament (feathers and and spruce twigs removed.)

"Montezuma defeated the enemies, raised the siege of the caves and cliffs, and drove the savages out of the narrow canyons. He trained the people in the arts of war. He led them out into the open country. He routed the hostile tribes in encounter after encounter, and at last expelled them from the region. He instructed the people to build villages in horse-shoe shape with continuous outer wall, so that they both served as places of residence and as fortifications. He taught them their religious rites and ceremonies. He instituted the sacred hunts. He taught the people to paint their houses and edifices of worship in representative figures of the gods. He made the column dancers the sprouters of grain; the 'funny men' the maturers of grain and of everything that lives and grows upon the earth. To the god-clown dancers he gave the power to represent men before the deities. To the medicine men he gave the power over the 'sick' and over death. To the

sun priest and his aids he gave the power to intercede between those above and men.

"For a long, long time he lived with them, extending their territory, building pueblos, and erecting temples to the sun. Finally, after he had made them a powerful and prosperous people, he called them all together and told them that there were many peoples that he must teach as he had taught them, and that he must go and instruct them. 'Then,' said he, 'when I am gone you will neglect to do the things that I have taught you. Therefore will my father, the sun, come in his wrath, destroy your pueblos, and give your fields to another race. After that will you return to do the things I have commanded you. Then when you have returned from your evil ways will I come on the wings of the morning, in the chariot of the sun, expel the intruder from the land, restore you your ancient possessions, and establish you in all your former glory.'

"After Montezuma had departed the people did exactly what the great man said they would. They departed from keeping his sayings, quarreled among themselves, and finally became divided. Our division came to this valley; the other went to Pecos, over the mountains toward the rising sun. In this valley our people builded village after village, only to have an earthquake throw them down or to have them razed to the ground by some of our many enemies. Finally only one village remained. It was situated on the isolated mesa yonder, at the junction of Guadaloupe and San Diego canyons. Against this place the palefaces came with their cannon, and, after a many days' battle, reduced it to the mass of ruins it is this day. Some of our people escaped to the Navajo country, but the greater part of them were captured and reduced to a state of servitude. While thus under Spanish yoke the people built the village and church of San Juan de los Jemez, at the boiling springs (Perea), and the village and church of San Jose de los Jemez, at Canyon, the ruins of each of which still remain. Then the Indians rose against this race of intruders (1680) and killed them all at the two villages. But more palefaces came and took possession of the land again. This time they moved us all to the valley where we now live. Since then have we done penance and mortified our bodies to appease the wrath of .the great father. And each morning at the early dawn we send a man to the top of the mesa yonder to see if the great Montezuma is coming with his father on the flaming wings of the morning to

expel this race from our land and restore us our ancient possessions—"

The drum-beat and the monotonous chanting of the musicians drowned the war-captain's voice. The double column reformed and the dance was resumed. Around the plaza the dancers proceeded as before till the processional movement was completed. The sowing-and-planting act was then given. In this act the columns separated and faced each other. The dancers kept time with both the hands and the feet for a minute. Then the columns joined at the ends and spread out in the middle area so as to form an ellipse. Around this all danced in a side movement to the right till each individual faced his respective partner again. Then the partners passed each other in a vigorous forward movement, turned quickly to the right with sweeping motion, and leaned forward nearly to the ground, the men swinging their gourd rattles as if sowing grain, the women sticking the ends of the ears of corn in the ground in imitation of planting corn.

At this instant the women rushed out of their houses with baskets of eatables, ears of corn, gourds, melons, wheat bread, corn cakes, etc. These they threw up into the air in all directions. When the baskets were emptied, they replenished them and tossed the contents toward the abode of those above. Of these eatables whoever could catch anything that fell proceded to do so. A general scramble followed, which would remind one much of a sheep-salting scene, or probably more like feeding swine in a trough in the center of the hog-yard. In this act of throwing heavenward the food which heaven has enabled it to raise, the whole tribe displayed its gratitude to those above, and the dance was the harvest-dance.

Thus were the varied scenes continued throughout the entire day. Then all lined up in double column with columns facing each other. Between these lines the cacique and his aids marched backward and forward for a considerable time, sprinkled their hearers with sacred meal, and prayed to their gods. This scene closed the dance.

THE OPEN-PLAZA COLUMN DANCES.

These dances are similar to the masked dance above described, except that none of the actors are masked and only the women wear head ornaments. At Jemez the clown element is usually wanting, but at Zia pueblo it is represented in its full strength. These dances are had on Catholic feast days and follow mass at the Catholic church. The image of the saint of the day is carried to a

booth in the plaza by a procession from the church before the dance begins. The dance in honor of San Juan (June 24) and that of the patron saint, San Diego (November 12), are the principal dances of this type. The latter is followed by an elaborately prepared feast. The former, besides the feast element, has a mock torrel combat (bull fight) preceding and accompanying it, a "gallo" (rooster) race between acts, and is followed by a water-throwing performance.

The torrel combat begins the evening of the 23d of June, continues in the streets and plaza and around the church while mass is said on the 24th, and flanks the procession with the image on its way to the plaza, and keeps up a general hurrah throughout the entire day. In this peculiar mock performance a man leading a mock bull—a bull hide stretched over a wooden frame supported by one or more men with head and body obscured in the frame—enters the plaza followed by a dozen or more rough, dirty, shabbily dressed, slouch-hatted boys and men, representing Mexican cowboys. At intervals these cowboys tease the bull with sticks till he gets enraged, bellows, and charges upon them. Feigning to be overcome they fall before him in the mud and water, if any is to be found, and are trampled under foot by the enraged "beast." Being then free, the "beast" charges upon whoever may chance to be in the street at the time, making women scream and scaring children nearly to death. The keepers, then wallowing in the mud till it would be hard to tell by their appearance that they are human beings, make chase after it, and after much cracking of whips, bellowing and hallooing they recapture it. In the intervals while the mock bull is quiet its keepers take it from house to house, and from the inmates receive offerings of bread and other eatables, to be presented as an offering to the gods whose symbols are in the estufas.

In the "gallo" race, all the boys whose given names are John (Juan)—as it is St. John's day—have to furnish a rooster each for the race. These roosters, one at a time, are buried in the soft sand in the plaza, all but their heads. Then practically all the young men of the village, mounted on horseback, gallop by where it is buried, lean over in the saddle, grab at its exposed head, and in case any one of them succeeds in seizing it, he endeavors to pull it, struggling, from its buried position. When once it is in possession of a rider, the real race begins. All try to take it from him, while he, with horse at a full run, pounds his opponents with the squawking chicken as they gallop over hills and valleys and through canyons.

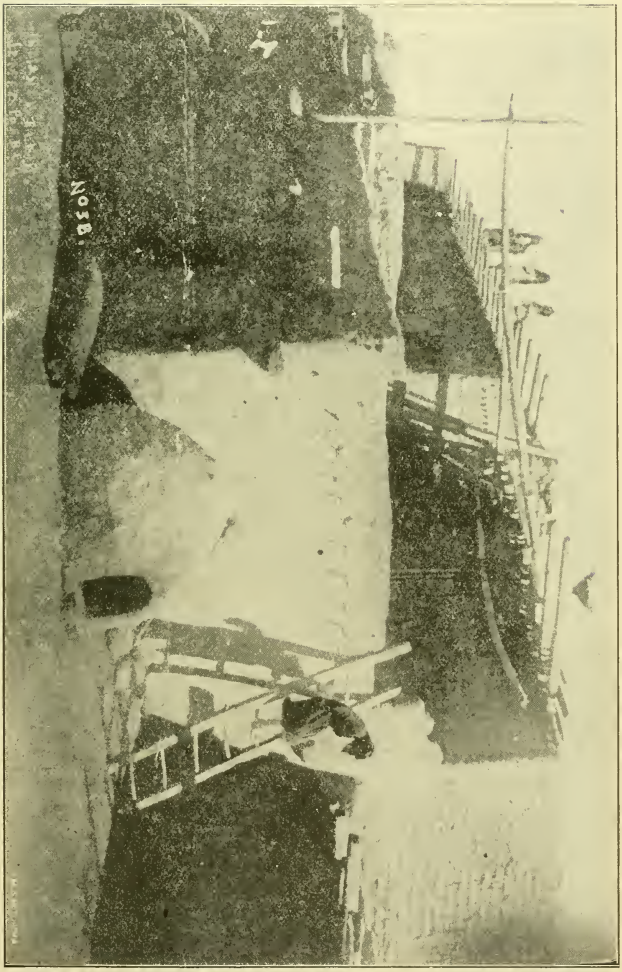
At last an opponent gets a hold of the fluttering fowl. Then they pull till the rooster is literally torn to pieces. Then they contest for the pieces in the same manner till there is not a piece left large enough for two people to get hold of. Then another rooster is buried in the plaza and the race is resumed. Thus is it continued till all the Juans have furnished their respective quota of roosters and until every participant in the murderous race is as bloody as though he had been in a gladiatorial contest.

In the water-throwing performance the women carry water to the house roofs till they have filled every water-containing vessel they have. Then, just at dusk, all the men of the village, with clothing removed, ride through the streets and close to the houses in every direction at a full gallop. As they do this the women throw water on them from the housetops. This performance is a prayer for rain.

THE CEREMONIES OF THE DEAD.

Immediately after a Jemez dies he is buried, usually with his personal belongings. Then the women of the family, aided by the medicine men, draw on the adobe floor of the living-room of the house of the deceased a large sun circle, with four projecting darts of protection, one in each of the four cardinal directions. Within this circle they then place a small, crudely carved wooden effigy of the dead one. Over this they throw a new piece of cloth. Then on one side of this effigy they place a new earthen jar filled with water; on the other side a basket of eatables, that have been prepared since the death of the deceased. These things they furnish so that neither thirst nor hunger should cause the traveling spirit to suffer. Furthermore, as the road the soul has to travel is long, dangerous, and beset by evil spirits lying in wait to capture the defunct or hamper his ultimate felicity, they lay beside the image a small war-club and a bow and some arrows, within the representative circle of the god of day, to protect the deceased from harm in his transit. Moreover, to render the journey safe beyond a doubt, they then draw without the circle the footprints of the great Montezuma, the "road-runner," who protects the soul in its journey to the abode of the good Indian dead.

As soon as these things are done, the relatives gather around the image and the drawing and weep, sob, scream, yell, howl, dance, sprinkle sacred meal and corn pollen, and pray loudly to those above for the safe journey of the departed soul and its arrival in the land of bliss. This performance is continued for four days. At about three o'clock in the afternoon of the last day the man an-



INDIAN DWELLINGS, SHOWING THE OVEN.

nually appointed for the purpose goes to the house of the deceased, obliterates the sun drawing encircling the image of the dead, carries the effigy, basket of eatables, water-jar and everything that pertained to the departed to the edge of a canyada to the east of the low mesa east of the village, and hurls them to the valley below. Over them he then sprinkles sacred meal for a moment. This completes the ceremonies; the journeying soul has reached the land of bliss.

THE ANIMAL DANCE.

In the first act of this dance, as seen by the writer in February, 1900, the medicine-men took all their medicine accouterments to the plaza and laid them in a row in a line with the sun, with the most important one, according to the Indian notion, heading the list, then the next most important, and so on till the long row was completed. Beginning at the head of the list, they were arranged as follows: Idols, bowls of corn pollen and corn-meal, groups of eagle feathers, medicine beads, the skins of snakes and birds, the left front legs of bears, bunches of rabbit wool, and the head coverings of beasts. When the things of medicine were arranged, the men of the village, followed by the women, passed down the long line in a stooping position and, each one having blown his breath on his left hand, stroked the curios one by one with it as he sprinkled the sacred meal over them at the same time with his right hand. The Indian believes that the strength, cunning or health powers of the medicine things they thus stroke and sprinkle with sacred meal will be imparted to them.

As soon as all had stroked and sprinkled sacred dust on each of the things in the medicine line the curios were removed from the plaza, and two men, carrying parallelepiped-shaped drums made of corn husks, entered the plaza and seated themselves on opposite sides of the public dancing area so as to face each other. They then began to beat their curious-looking musical instruments with drum-sticks that resembled potato-mashers, except that they were were much larger. Scarcely had they seated themselves when the caciques and "principals" gathered around them and began to chant and gesticulate to the earth, the animals, and the other sacred things on the earth, and to those above.

This chanting was only just beginning when men, dressed in the skins of animals or birds, all wearing masks as near as possible in the natural shape of the head of the animal or bird they respectively represented in imitation, came cantering, galloping, crawling or "flying" from one of the dressing-rooms to the plaza and com-

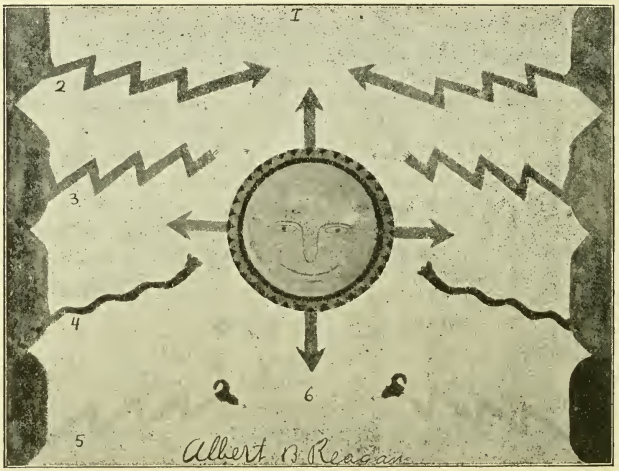
menced performing according to their respective kind. The buffalo pawed the earth and bellowed. The rabbit and the deer leaped from place to place. The turtle proceeded slowly to move about. The turkey gobbled and strutted. The coyote howled. The bear growled. Followed by the chanters these odd performers moved slowly across the plaza till the whole public space was danced over. The cacique then sprinkled all the participants with sacred meal. The actors then dispersed. A new "set" formed, and the previous extravagant actions and strange ejaculations were gone over again. This performing they continued till "Sol" began to hide his face beyond the western highlands. The cacique then sprinkled all present with sacred meal, and the animal dance was completed.

THE MEDICINE DANCES.

These Indians, like all Indians, have medicine dances to cure the sick. These are usually held at night. During them the chief medicine-man sprinkles the patient with sacred meal, prays to the gods, contorts and otherwise mortifies his own body, doctors the patient by a crude process of massage, and occasionally gives him root-tea to drive "sick" away. While he is doing this a houseful of nude men often dance around the couch of the sick one. These dance and chant with the doors of the room closed till the air in the room is nearly foul enough to take one's breath. When they have performed as long as they can stand it in the ill-ventilated room they rush out into the streets and plaza and run hither and thither, uttering shriek after shriek that would make any white man's blood run cold. This shrieking is done to drive out the evil spirit "sick." The sick one usually dies.

THE BOW-AND-ARROW DANCE.

At dusk the evening before the dance, as seen by the writer in August, 1900, the cacique and his aids made the rounds of the village, prayed, and sprinkled corn pollen in every house and over each inmate of the same. Then to the estufas they proceeded, and sprinkled the sacred meal before the symbolic paintings and over the images of the gods brought thither for the dance preparation. Then the sprinkling in the estufas being completed, four of the caciques left the north estufa and went one in each of the four cardinal directions for a distance of about a half a mile. Reaching their destination, each cacique lighted a low fire and then sat down beside it so as to face the silvery faced moon. As soon as seated each began to beat a small drum and chant to his deities. This they continued till morning.



SUN-GOD SECTION.
In one of the estufas at Jemez, N. M.

1. Clouds, the steps to heaven.
2. The bolt lightining that does not strike the earth.
3. The bolt lightning that strikes the earth. It is the red snake or Indian devil, called Savah by them.
4. The flash lightning, the god of flowers.
5. The good snake, the blue snake, the god of rain.
6. The sun, the father of the universe, and the god of all things. By the Indians he is called Patahgatziah or Pay.

(Printed in the proceedings of the Indian Academy of Science for 1903.)

At sunrise the next morning twelve chanters and a drummer entered the plaza from the south estufa, and began to sing and lift their hands towards the heavens as if in supplication. It was the beginning of the bow-and-arrow dance. Soon the dancers, two in number, a man and a woman, descended the ladder of the estufa backwards. Both had their faces, arms and all exposed parts of their bodies painted or daubed in red war paint. The woman, a virgin, let her hair hang loosely over her shoulders; her dress was of heavy black cloth, embroidered in shells, in silver badges, and in stones precious to the Indians. Her feet were bare. From her neck at the front suspended many strings of shell and turquoise beads. From the top of her head to the bottom of her dress at the back she wore a feathered cord. In her right hand she carried a bow and some arrows; in her left, a tomahawk. The man had his hair bedecked with feathers. He wore coat, leggings, and mocca-

sins, each made of buckskin, beautifully fringed, and painted in symbolic designs. At his back he carried a quiver filled with arrows. In his right hand he gripped a bow; in his left he held a heavy rawhide shield, on the front of which was painted the symbol of the sun.

Entering the plaza, the dancers crow-hopped, leaped, tripped or danced as the meaning of the chant demanded. On separate lines in front of the slowly forward-moving musicians and the populace who had joined them, they danced back and forth the full width of the public dancing area, the squaw facing and dancing in one direction, the Indian in the opposite. As they thus danced, the half of the time that they faced each other the squaw, in mimicry, shot at her adversary and drew her tomahawk to scalp him. At the same time her approaching foe defended himself with his shield and went through the motions of shooting at her with his bow. Passing each other, they each leaped and crow-hopped at a rapid pace to the turning-point in their course. As they thus danced the squaw lifted the tomahawk and the bow and arrows alternately above her head, and the Indian elevated first his shield, then his bow and arrows, with a quick, vigorous thrust. Reaching the turning-points in their respective courses, the inner dancer swung around the outer one to a line in the rear. The other dancer then wheeled about and performed in the reverse direction over the line he had just danced. When these dancers had moved in a sidewise movement across the entire plaza they retired, and a new "set" took their places and danced the very same dance over again—nothing ever gets monotonous to an Indian. In this manner, when one "set" broke up another took its place, till night commenced coming on. Then the war-captain and caciques lined the people up and prayed over them, as they sprinkled them with sacred meal. This closed the ceremonies.

THE AUGUST DANCE.

On August 2, 1900, thirteen Indians entered one of the estufas to fast and pray to complete the act of maturing the crops. On August 6 they completed their work, and, leaving the estufa, purified themselves in the river. As soon as they returned to the village there followed a plaza dance, which lasted till night. In this dance the old men danced around the drummer as they waved their hands to bring out the meaning of the song. The dancers, a man and a woman, were gaudily dressed. Both had their hair bedecked with the long feathers of the eagle's tail. The man carried a gourd rattle in one hand and a tomahawk in the other; the woman, a toma-

hawk in her right hand and a bow and some arrows in the other. In the dancing they commingled with the musicians, winding backward and forward, not unlike a snake in his crawling, as they advanced, the woman in the lead. When the woman reached the front, the bystanders threw bread and various other things into the air, to shower down upon the performers. The scrambling for these things was wonderful to see. When the residue had been trampled in the ground as a thank-offering to the gods, the musicians formed in double column and the dancers danced in the open space between the files. The principal performance was acted by the female dancer. She danced and leaped about like a jack-rabbit, lifting first the bow to heaven as she leaped to the left, and the tomahawk as she leaped to the right. This dance was another elaborate prayer for rain and for the maturing of the crops.

THE BUFFALO DANCE.

This dance consisted of two dancers, a man and a woman. The man was dressed in a buffalo hide. While dancing, he held a bow and some arrows in his right hand and a tomahawk in his left. The woman was dressed in gala attire, jeweled, and beaded. For a head covering she wore the complete neck and head skin of a buffalo. The dance was a peculiar knee-springing, foot-scraping forward and then backward movement. It lasted the whole day.

THE DANCE GIVEN IN HONOR OF THE BISHOP.

In the fall of 1900 the Catholic bishop of Santa Fe visited the village of Jemez and, while he was there, the Indians gave a dance in his honor. In this dance the dancers were men, four in number. Each of these, besides being painted and conspicuously dressed, had suspended at his back, from the crown of his head to his ankles, a line of war feathers so arranged on a buckskin cord that they kept a horizontal position. In dancing, the dancers lined up in a line abreast and acted out a vigorous stamping dance, varied occasionally by one of the dancers stepping out from the line and dancing a clumsy, grotesque jig in front of the bishop. The dance lasted about three hours.

THE BEAR DANCE.

In the fall after I went to Jemez there was a religious bear hunt, and some twenty men went to the mountains to hunt bear. After they had been gone about a week I heard a great hallooing and the firing of guns in the hills across the river west of the village. At that instant some one in the village yelled, "They have killed a bear! They are coming! A bear! A bear!" In a moment the

whole village was vigorously astir. Men, boys and squaws were on the house roofs, in the streets and plaza, and running to the river to meet the hunters, all at the same time. Excitement completely ruled. The people of the village, on reaching the river, plunged into it, swam and waded it, and made a mad rush to the leading horse of the home-coming procession, to be the first to touch the bear hide carried on this horse and to be the first to blow a hissing breath on it, so that they should receive a special blessing of the gods. On meeting the home-coming party they turned about and all entered the village in a long-drawn-out procession. On arriving at the village, the hunters rode completely around it and through each street, and stopped before each house as they sang the bear song and fired guns in the air. Completing the village in their singing, they stopped in front of the house of the hero of the hunt, the young man who got his hand on the dying bear first. As soon as they stopped, the mother came out with a club, dragged the bear hide from the saddle, put it on her shoulder, and danced a clumsy jig with it as she made a speech to those present. Finishing her dancing she threw the hide to the ground, jumped on it and pounded it with the club, while she shrieked a hideous "Wow, wow, wow," as she batted her mouth with her left hand to make the noise the more terrible. After pounding the hide for several minutes, she took it into her own house and stretched it on the floor with head near and toward the fire a moment. Then she took it and laid it in the front part of the room near the door Then each and every Indian of the village entered the house, blew his breath on his right hand, and stroked the bear hide with it. Then, lighting a cigarette, he left the room and went to the plaza to hear the hero tell of the adventures of the trip, and of how he succeeded in killing the bear.

This, I learned afterwards, is only a small part of the bear ceremonies. At another time I saw the remaining ceremonies performed, with the exception, however, that they were performed with a live cub bear. They were as follows:

One morning at daylight, in the fall of 1900, the war-captain and his aids, in broad, sonorous, strongly accented words, gave the following order to the people as they made the rounds of the village: "Fast and pray these four days. Take part in nothing pleasurable these four days. Go to your homes and do penance."

For four days no one moved about the village. The streets were deserted. The dwellings and estufas, however, were astir. Within them every one was occupied in religious ceremonies. In the

estufas the "principals" beat small drums, sprinkled sacred corn pollen before the images and symbolic paintings, and chanted prayers to those above. In the houses, before the altars, paintings, and household gods, the inmates prayed, tortured themselves, and danced without ceasing.

As the fourth day began to draw to a close, the caciques entered the plaza and kindled small fires at various places. Around each of these they set seven sticks in a line in each of the semicardinal directions. Over these they sprinkled sacred meal and prayed for a considerable time. Then they took up the sticks and, as they blew a hissing breath on them, they put them in the fire one by one.

When the stick burning was completed, four men issued from the south estufa and went one toward each of the four points of the compass. Each of these men carried a young pine in his left hand and a bowl of sacred meal in his right hand. Each pine tree thus carried has seven feathers suspended from it to the breeze, each tree and its feathers symbolizing the Jemez tribe. These trees their bearers planted quite a distance from the village. Then over them and their fluttering feathers they scattered the sacred dust, dedicating them to the moon mother, whom the Jemez believes protects his home and village. They then returned to the village.

Throughout the following night men dressed in deerskin embroidered in symbolic designs raced the streets and plaza at a coyote gallop, shaking their shell bells and gourd rattles, and sprinkling the dust of the gods toward the goddess of night.

At daylight the next morning every one in the place bathed, rinsed out his stomach with warm water, and combed and did up his long hair, according to the Indian custom. Nothing more of note occurred throughout the day.

At dusk a drum on the south estufa sounded and a new set of scenes was ushered in. "Wow, wow, wow," shrieked an old woman, as she batted her mouth with her hand to make the noise as hideous as possible. "Wow, wow," she continued, as she entered the plaza, carrying a club under one arm and a cub bear in the other. "Wow, wow," she shouted, till the people filled the plaza about her. Then, as she took the innocent little animal by the neck and shook it, she ceased her "wowing," and said:

"Long, long ago our mother, the moon, went down to the river in the early morning to get water to use in cooking breakfast for our father, the sun. She dipped the water-jar into the flowing

water and filled it nearly full. Then, to complete the filling, she took a gourd cup, as we all do, and commenced dipping up cups of water to put into the jar. Once, as she was leaning over to fill the cup, a bear, which had approached unnoticed, seized her from behind and carried her to his great cave in the mountains. In the entrance he then rolled a big rock, so that she could not escape, and there he kept her, bringing her food to eat each day.

"After she had been there a great while she gave birth to a male child, the son of the god of day. This child grew to his full maturity in this cave. He could not get out, because on leaving in the morning to search for food the bear always rolled the rock in the entrance, and on his returning he closed it behind him with the same rock. But, after obtaining his full power, this offspring of the parents of all things was able to roll the stone away and go where and whenever he pleased. He always contrived, however, to go out after the bear had departed in the pursuit of game and to return before that animal returned at the close of day.

"At first this son of the moon mother thought that he was the offspring of the bear, but his mother told him who his true father was, and related to him how it happened that she was in that miserable condition. From that time on the mother and son talked over plans of escape. At last they made up their minds what to do, and at the first opportunity they failed not to put their plans into execution.

"As soon as the bear was out of sight and hearing one morning, the son of the great mother rolled the stone from the cave entrance, put his mother on his back, and ran and ran and ran all day toward the place where the sun sets, because he knew that the sun touches the earth on all sides of the great hole at his going down. Towards night they could hear the growling bear coming in the distance. Harder and harder ran our first brother with our mother. Nearer and nearer came the bear. With open mouth he got so close to them that his breath blew in our mother's face. With a horrifying growl, the animal sprang to seize her. At the same moment our brother, with one great leap, reached the palace of the sun. The great gate closed and shut the bear out.

"But the terrible beast charged upon the gate and would have broken it in pieces had not our brother left his mother and drove him from the palace front with his mighty war-club. Bent upon having his wife, as the bear styled our mother, he then attacked the palace from the rear. On this side another one of our brothers, a son of those above, defended the edifice and drove the infuriated animal away.

THE MOON-GOD SECTION.
In one of the estufas, Jemez, N. M.

1. Clouds.
2. Bolt lightning that does not strike the earth.
3. The red snake or Indian devil.
4. The flash lightning, the god of flowers.
5. The blue snake, the god of rain.
6. The moon, the mother god of the universe (called by the Indians Ahtahwahtzah or Pah.

"To reward these defenders of the sun's wife and of his home, the Great Spirit made our first brother the morning star, and the other brother the evening star. They are in the heavens, as you have all seen them. The morning star still guards the entrance to the sun in front, the evening star the entrance in the rear.

"Ever since the rescue the bear and his descendents have been enemies of the moon and her children, and ever since that time it has been the woman's duty to destroy the bear every chance she can, to avenge the wrong done the moon mother in the long ago. Our sons capture or kill them, and we take revenge on the living animal or upon his lifeless hide."

"Wow, wow," shrieked the aged squaw again. The lookers-on "struck up" the bear chant. The drummers, who had arrived, beat the drum. The aged squaw danced the bear dance, shaking first the club towards the god of night, then the struggling little bear. The cacique sprinkled the dancer with sacred meal and

prayed to those above. The old woman dropped the bear to the ground, and as the helpless little thing howled and cried most pitiably, she beat the life out of it.

Picking up the animal's lifeless body, the old woman shook it vigorously. Then dancing across the plaza as she shrieked and batted her mouth, she entered her own house and laid the bear with head to the fire a moment. Then she took it and laid it in the rear of the room. Here the populace followed her. Hither to her house the women then rushed with baskets of eatables. Hither into this house entered the populace. As they entered each one blew his breath on his right hand, patted the bear a moment with that hand, passed on, squatted on the floor, and partook of the eatables till he had satisfied his hunger. Then all arose, lit the ceremonial cigarette, and passed out again into the public dancing area.

Here, seated in the center of the area, the Indian who had touched the bear first when it was captured was telling every one his hunting adventures and the difficulties he had in capturing the cub bear which his mother had just killed. He had told them the same story before when they had returned from the hunt, but it was still new and interesting to his hearers.

As the hero was thus relating his hunting trip, men dressed in breech-cloths, their bodies painted in symbolic colors, their hair decked with feathers, entered the plaza and began to dance in single file back and forth across the public dancing-ground, as the chief penitents beat drums, sang the bear song, and gesticulated to bring out the meaning of the same. Soon almost all of the men and boys joined the musicians, and, as all sang and shouted at the top of their voices, the whole procession, dancers included, moved toward the general feast house of the pueblo. As they neared it, the women rushed out of their houses with baskets of eatables. These they threw skyward, to shower down upon the dancers and chanters as a thank-offering to those above.

On entering the feast hall, the aged woman, with the hide of the cub bear she had killed, headed the procession, dancing, "wow-wow-ing," and batting her mouth with her hand. Thus performing, she encircled the middle space of the room twice. She then proceeded to her son, the hero, blew her breath on him in blessing, gave him the hide, and immediately left the room.

As soon as the mother had departed, the cacique sprinkled the bear skin and its possessor with sacred corn pollen, as he prayed to his gods. He then cut the left front leg from the hide and placed

it amongst his medicine curios. Then, while the populace danced from left to right around him, he laid the hide on the gound and stamped on it, as he again prayed and sprinkled the sacred dust.

The scene at once changed: With one blow, the war-captain severed the scalp from the hide and hoisted it on a pole; then around this the men danced the scalp dance for hours. This was continued till day began to dawn. Then all present seated themselves in the big house or in the street just outside of it. The breech-clothed dancers then served them with eatables. At the rising of the sun the cermonies closed.

THE CORN DANCE.

At dusk one evening in the late summer of 1900 every man, woman and child that could walk prepared prayer-sticks, feathered them, and then all set out in a long-drawn-out procession, in Indian file, to the bank of the Rio Chiquito, north of the village. Here they tossed the sticks out from the mesa wall to the valley below. Then after them they cast the pollen of the gods, as they prayed to the rulers of heaven and earth. They then marched back to the plaza in the same manner as they had come.

Reaching the public dancing plat, the returning people lined up, and the representatives of each clan marched to its respective estufa, climbed up the ladder to its roof, and entered it through the hatchway. Then around the center post, which supports the roof, they danced and prayed to the god symbols on the walls, while the caciques sprinkled them with sacred pollen. This they continued to do till about eleven o'clock in the evening. Then they left the estufa.

On leaving the estufa some of the men went to digging holes in the plaza; some went to cutting down pine trees and dragging them to the plaza; others, under the direct guidance of the cacique, began to prepare a long pole by peeling it and painting it in colors, so that it looked much like a barber pole, except that it was many times larger. When painted they put a cross on it. Over this they suspended a large wreath of corn leaves, interwoven with spruce twigs. Meanwhile the men at the plaza set the trees in the ground so as to make a crescent-shaped grove, with open space facing the north. This completed the night scene.

At sunrise the populace gathered around the painted pole and, with a great shout, raised it to a vertical position. Then before it, that is, between it and the village, the dancers, two men alternating with three women, lined up abreast, facing the pueblo. The women were dressed in black cloth, richly embroidered in shining

stones, in shells, and in shining silver pieces. The men wore coats of bucksin and leggings and moccasins of the same material, beautifully fringed and embroidered with shells of various kinds. They also wore an outer garment of buffalo hide. The women were bareheaded; the head-dresses of the men were deerskins and feathers of the war eagle. To finish off these singularly rich and elaborate head-dresses there was added to each a pair of buffalo horns, reduced in size and weight and arranged as they grew upon the animal. To give the whole dancing suit a more striking appearance, the dancers had suspended at their backs, from the crown of their heads to their ankles, a line of war-eagle feathers so arranged on a buckskin cord that they kept a horizontal position.

When they were all lined up, the drum on the south estufa sounded. The dancers then danced slowly to the public dancing plat. Behind them the pole was laboriously carried. On reaching the plaza with it, it was set in the ground just west of the artificial grove. The dancers then retired to the nearest estufa, as the caciques prayed and sprinkled the sacred pollen to the breeze.

Soon the five dancers, the two men and the three women, reappeared and formed in column abreast inside the crescent arch with their faces turned toward the north. The musicians came next, two chanters, two drummers, and two flute players. Following these came the squaws of the place. They were gaudily painted and dressed. Sparkling ear pendents dangled from their ears, and ring upon ring of shell beads encircled their necks and reached almost to their waists in front. These squaws formed in line to dance in a great circle, having the striped pole, the grove and the musicians at its center; four men danced with the squaws, one in each quadrant of the circle. In dancing, these tripped it sidewise to the left, moving their feet about four inches at a step; while, as a countermovement, they waved their hands, first the right and then the left, to the time of the music. In these waving hands they gripped ears of corn. The moving around the entire circle by each participant completed a dancing set.

The women of the special dancing group of five tripped it lightly five steps in succession as they alternately waved ears of corn in their hands; the men vigorously stamped and shook the gourd rattles they carried in their left hands and waved the bunches of pine twigs they carried in their right hands. Then all wheeled about so as to face the east. Then five steps more were tripped or stamped; a whirl to the south was then made. This time the dancers raised their hands alternately above their heads in a vigor-

ous thrust as they danced. Wheeling so as to face the west, both hands were simultaneously elevated above the head, and five steps were emphatically stamped by both men and women. Turning on their heels so as to face the north, they began to dance as at first. Thus they continued to perform throughout the whole "set," and from set to set, till the ceremonies were brought to their consummation.

At the close of each set the actors retired to their respective estufas, and another set of performers, after they had been sprinkled with the sacred dust in the presence of the symbolic paintings of the sun edifices, came from those houses, similarly costumed, to take their places.

Just as the first set was breaking up the "funny men" came tumbling and rolling into the plaza. They were the same black and white clowns we have met with before; but in this case their bodies were decorated with corn strung on cords of buckskin and hung over their shoulders like wreaths. They were not so funny now as when we first saw them. Their principal duty at this time was to present to the gods the wrong-doings of the tribe. This they proceeded to do, in imitation, to the limit, as the lookers-on shrieked and howled with mirth. When the next dancing set formed, the clowns retired to the estufas or laid down to rest in the shade of the grove till the set was danced through. Then they became active again.

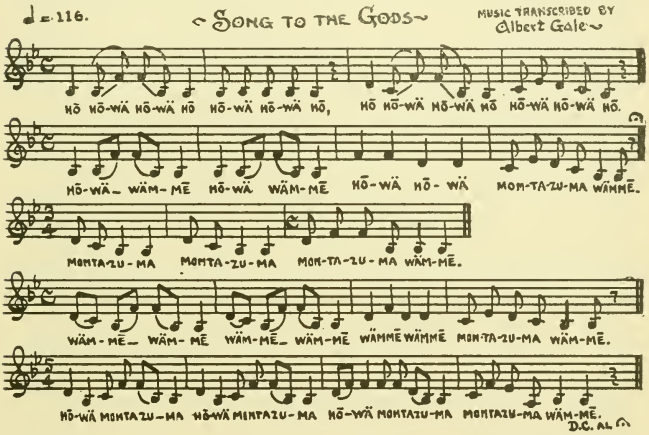
Thus, throughout the whole day, dancing scenes alternated with clown performances till evening claimed the land. Then all lined up in double column, with columns facing each other. Between these lines the caciques marched backward and forward and sprinkled all with the sacred dust. Then the columns marched to the inner room of the chief cacique's house and deposited the ears of corn they carried in their hands or had suspended at their shoulders. This corn they gave as an offering to the gods for the bountiful crop they had raised. The dance closed with this scene.

THE SNAKE DANCE.

This dance was seen at Zia pueblo, but the Jemez have it also. It is there a secret ceremony, performed at night, the same as at Zia.

Just at dusk, at the full of the moon, in August, in 1899, the antelope priests went to the place where they had collected snakes of every kind to be found in the region. These snakes they fed till they would eat no more. Then, after they had sprinkled them with sacred meal, they took snake canes having feathers suspended

at one end, and with these they rolled the snakes around, waved the feathers over them till they became bewildered and uncoiled, if they had coiled. They then picked them up one by one with their bare hands, put them in large earthen jars, covered them over in the jars with a buckskin covering, and then carried the jars on their heads to the central estufa. These they placed around the central post in that house. Then around them, in the presence of their idols and the symbolic paintings of the house, they danced, sprinkled sacred dust, and prayed for a considerable time.



MUSIC (SONG)
Used in the round dances in the estufas.

Then men, dressed only in breech-cloths and bearing no weapons whatever, left the pueblo one after another, in a long-drawn-out procession, and marched with majestic tread to a point on the adobe flat about two miles northwest of the village. This being reached, all lined up abreast, facing the village. Then, at a given signal of the chief antelope priest, the snake race was on. Instantly the competitors were running like deer over the parched ground. For a few moments all kept pace with each other. Then four or five began to lead out. Then two of these made gains on the others. Then one of them began to outstrip the other. Nearer and nearer the goal they came. Across the public dancing area the leader dashed to the estufa. With one bound he leaped upon the roof, a tall, muscular, powerful Indian, with gleaming, piercing eyes. Amid

the shouting of the breathless spectators, the chief snake priest placed a wreath of pinyon twigs on his head. Triumphant and panting, he then left the roof of the estufa.

Immediately following the race, a horrible, blood-curdling ceremony begun in the estufa. There some of the snake priests, dressed in fantastic garments, stood a moment over the jars containing the slimy, wriggling, crawling snakes, sprinkled the yellow powder to the four corners of the earth, and muttered half audible incantations. Then, as they uttered a low, rattling noise, they took the reptiles from the jars and passed them to six other snake priests, as we would hand a bunch of shoestrings to another person. The latter priests squatted about a large bowl containing a dark red, medically prepared liquid in which the snakes were to be washed. As soon as the passing of the snakes commenced the musicians began a low, humming chant, the roughly handled snakes hissed or rattled, the big drum measured out the time, and the squatting priests beat it with their writhing snakes. This humming, rattling, hissing and drum-beating grew gradually louder and louder, and wilder and more barbaric and ferocious, until it burst into a fiendish shrieking and howling. Just as the excitement had reached its height the squatting priests grasped the snakes by their necks, thrust them into the liquid, drew them out again, and dashed them furiously upon a sanded circular plat called the snake home. Around this snake area stood three other priests with snake whips to prevent the hissing, rattling, infuriated reptiles from coiling as they fell. This they succeeded in doing by a process of rolling the snakes about in the sand. As the snake bathing progressed the fanatical excitement grew more and more intense. The low, murmuring song broke into wild, hideous, unearthly shrieks. The six priests grew more wild and fierce. With red-stained hands they vigorously dipped snake after snake and dashed it furiously down upon the sand till all the snakes had been washed.

The snakes were then put back into the jars and carried to a level spot about two miles up the river from the village. Following them when they set out danced the antelope priests, much in the same manner as a baboon trips about in a cage. Their almost naked bodies were streaked with white paint, as were also their faces. Rattles of various kinds were tied to their knees. Embroidered dancing skirts of white cotton hung about their loins. Necklaces encircled their necks and extended nearly to the waist line in front, and coyote skins were suspended from the waist-belt at the back. The chief antelope priest, bearing the sacred symbol of his frater-

nity, headed the dancers. Immediately behind this priest followed the bearer of the sacred medicine bowl. All the other representatives of the order carried rattles in their hands, with which they kept up a continuous noise like that made by the sacred snakes. Four times around the leveled space they danced, and sprinkled sacred meal when they had arrived there. Then they lined up to await the coming of the snake men, whom they had passed on the way. With a majestic step the latter soon came, entered the enclosed space, and lined up, facing the antelope priests.

Thus lined up, the snake men presented a grewsome, diabolical picture. Their bodies were daubed with dark red paint. Their chins were blackened, and outlined with a broad white stripe. Their breech-cloths and their moccasins were dyed red with the blood of animals. From their ankles, knees, waists and necks suspended rattling, hideous-looking objects. In their left hands they carried snake whips. In the jars on their heads they carried the snakes that were to play such a prominent part in the coming exercise.

After the lining up of the snake men, for a moment there was a breathless silence. Then at a signal they lifted the jars from their heads and poured the snakes on the ground. At the same time a deep humming of artificial rattles began, followed immediately by a vigorous chant. The chant grew louder and louder. The two lines of priests swayed slowly backward and forward towards each other, like two lines of writhing snakes. The snake whips were constantly waved over the wriggling reptiles. The chief medicine-man of the snake ceremonies strode back and forth and scattered sacred meal. The snake-priest lines suddenly broke up into groups of three. The chant at once grew louder and louder. The dancers became more and more excited. One man in each of the groups of three dropped to one knee and arose with a squirming snake in his mouth. Around the leveled area four times he then danced with his snake, as another priest of the set of three to which he belonged waved eagle feathers before the reptile to attract its attention and prevent it from sinking its fangs into its bearer. Reaching the starting-place the fourth time, the snake was dropped to the ground, and was at once dexterously picked up by the third member of the trio. Thus were the reptiles gathered up and danced with again till every one in the collection had been danced four times round the circle in the mouth of a "carrier" of each group.

As the snakes were being danced with the fourth time, the chief

priest of the ceremonies scattered sacred corn pollen in a circle on the ground. Instantly a profound silence fell over all. The snake men advanced and threw down their snakes within the yellow ring. Then at a given signal, with a howl the whole medicine line made a mad rush for the circle, and each Indian seized as many snakes as he could carry in as many ways as possible. They then all made off with them in every direction as fast as they could go, to set them at liberty to carry the prayers of the people to the divinities for rain. The snake dance is an elaborate prayer for rain.

THE CLIMATOLOGY OF KANSAS.

By T. B. JENNINGS, United States Weather Bureau, Topeka.

IN reviewing the history of a country it is customary to divide it into prehistoric and historic. In writing of the climatology of this state we will divide it into two periods; the first period extending from the earliest reliable written accounts of its weather down to the time (1887) that systematic observations and records were practically begun over the entire state.

Though the state is young it has a few records that began in the dim past. The Fort Leavenworth record began in 1836, the Fort Riley record in 1853, the State Agricultural College record in 1858, the Kansas University record in 1868, the Independence record in 1872, and the Dodge City record with 1875.

THE PREHISTORIC CLIMATOLOGY.

FLOODS.

The old river boatmen give an account of a flood in the eastern part of the territory and in the Missouri river in 1785, which passed down that river and into the Mississippi, flooding the "American bottoms" across from St. Louis, and for many years was referred to as "the great flood." Twenty-six years later the Missouri river bottoms were again flooded.

About the last of February or 1st of March, 1826, heavy rains began in what is now the southeast quarter of the state, raising the Neosho and its tributaries out of their banks and flooding their bottoms; heavy rains continued in the territory during the season. In June the lowlands near the mouth of the Kaw were flooded, owing to high water in the Kaw and Missouri rivers meeting; in the fall a destructive flood swept down the Neosho, carrying away wigwams, houses, and gathered and ungathered crops.

In 1844 occurred probably the worst floods eastern Kansas has ever experienced. Rev. Mr. Meeker, who was missionary to the Ottawa Indians, and was living on what is now the town site of the city of Ottawa, in his letters gave a graphic account of the condition of the Marais des Cygnes and the destruction wrought by it at that point. From May 7th to the 20th there were nine days of rain, and daily, 23d to 29th, inclusive; rain began again on June 7, and on the 12th the Marais des Cygnes overflowed its

banks, carrying away outhouses, fences, cattle, pigs, and chickens; the river began falling on the 14th and rising again on the 20th.

At Fort Leavenworth the rainfall for June, 1844, was 8.53 inches; July, 12 inches; August, 8.08 inches—aggregating 28.61 inches for the three months (normal annual precipitation for that place is 30.89 inches). Mr. Richard W. Cummins, of the Fort Leavenworth agency, reported to the government: "All those farming on the bottom-lands of the Kansas river, and other bottom-lands, lost their crops entirely; not only their crops, but nearly all their stock, hogs, cattle, and even horses. . . . The 'Konzas' farm mostly on the bottom-lands of the Kansas river, which was overflowed from bluff to bluff." S. M. Irvin, Indian agent in charge of the Great Nemaha subagency, reported: "The past season, you must be aware, has been a most unpropitious one for farming operations. The unprecedented fall of rain which took place in June and July, by which much of the best farming lands of the Indians was several times inundated, has been a serious drawback upon the aggregate value of the farming products."

W. W. Cone, in his Shawnee County History, speaking of the flood of 1844, says: "During the flood Major Cummings, paymaster of the United States army, wishing to cross from the south to the north side of the Kaw river, at Topeka, stepped into a canoe at about the present site of the corner of Topeka avenue and Second street, and was rowed by an Indian from there to the bluffs, near the present residence of J. M. Harding, in Soldier township, the water then being twenty feet deep over the ground where North Topeka now stands."

Mr. P. E. Chappell, of Kansas City, Mo., an old river steamboat man, states that the flood of 1844 in the Missouri river was confined to the lower river, and says: "The entire bottom from the Kaw to the mouth of the Missouri was completely submerged, and from bluff to bluff presented appearance of an inland sea." He further states that in 1845 and in 1851 there was unusually high water in the river, and all the second bottoms and low sloughs were submerged, and we find that at Fort Leavenworth 15.80 inches of rain fell during June, 1845, while in 1851 the Fort Leavenworth record shows, for May, 6.40 inches; for June, 8.16; July, 6.78, and August 5.02—a total of 26.36 inches.

THE DROUGHT.

Mr. E. C. Manning, in his paper "In at the Birth, and—" says in part: "During the winter of 1859–'60 the sun shone forty-five consecutive days through a cloudless sky upon a snowless plain.

Through the summer of 1860 the hot wind parched the soil and no harvest followed the seed-time; hence, the approaching winter brought an alarming outlook." (He was living in Marshall county then.)

Mr. Wm. H. Coffin, who settled in Leavenworth county in the '50's, speaking of the drought, says, in part: "In the great drought in Kansas, from June 19, 1859, to November, 1860, not a shower of rain fell at any one time to wet more than two inches deep, and but two light snows in the winter (1859–'60). Roads never got muddy, and the ground broke open in great cracks. There were no vegetables whatever, and a burning hot wind in July and August withered everything before it. Fall wheat came up in the spring, but withered and died. Most counties did not harvest a bushel. Low bottom-lands, where well tilled, gave some corn, but most other lands dry fodder. Prairie-grass grew until July, then all withered and died; enough to supply their needs was mostly secured from low bottom-lands. Wells, springs and streams dried up."

Hon. Geo. W. Martin, in an address before the Old Settlers' Association of Geary County, September 21, 1901, said, in part: "The changed condition in Kansas is indicated by the tone of the people during the recent dry spell. It is no easy matter to reclaim a new country, but the people of Kansas have accomplished marvels. The drought of 1860 began September 1, 1859, from which date there was no rain until September or October, 1860. . . . On the 13th of July the mercury went up to 112 and 114 degrees in the shade (the highest temperature at Manhattan was 115 degrees), and, with a hot, scorching wind, it kept at these figures for weeks. The leaves withered and fell off the trees, and eggs roasted in the sand at midday. The dates of the beginning and ending of the drought vary in locations, but it may be said that there were from twelve to fourteen months between rains."

Horace Greeley, writing in the New York *Independent*, of February 7, 1861, referring to the drought of the preceding year, said: ". . . Drought is not unknown to us; but a drought so persistent and so severe as that which devastated Kansas in 1860 is a stranger this side of the Mississippi. No rain, or none of any consequence, over an area of 40,000 square miles, from seed-time till harvest—wheat, Indian corn, buckwheat, successively deposited in the earth, to die without germination, or to start only to be blighted and wither for want of moisture."

Mrs. Susan M. Weymouth, in the *Daily Capital*, July 19, 1901, says: "The drought of 1860 gave to Kansas the ignominious name,

'droughty Kansas.' . . . It seemed for a time that the powers of heaven and earth were against us. . . . Previous to 1860 a good many trees were planted. The hot winds of that summer told on them, and in after-years the south side of the trees showed of the fearful heat which they had passed through, for there was always a dead part. That year will go down in history as having the hottest day on record. . . . It was in July, . . . a frightful day. People fled to their cellars and every door and window was closed. It was as if the wind was coming from a red-hot furnace for nine or ten hours.

"Next day we looked to see what damage it had done; birds, chickens and stock had succumbed, and the trees were badly injured; the tender things for two feet on the south side were as dead as if a fire had swept through them."

The year 1874 has been called a drought year, but it was not; it it was a grasshopper year.

(Subject to be continued as "Historic Climatology.")

NATURE PHOTOGRAPHY IN KANSAS—THE WORK OF MR. AND MISS McCOLM.

By Grace R. Meeker, Ottawa.

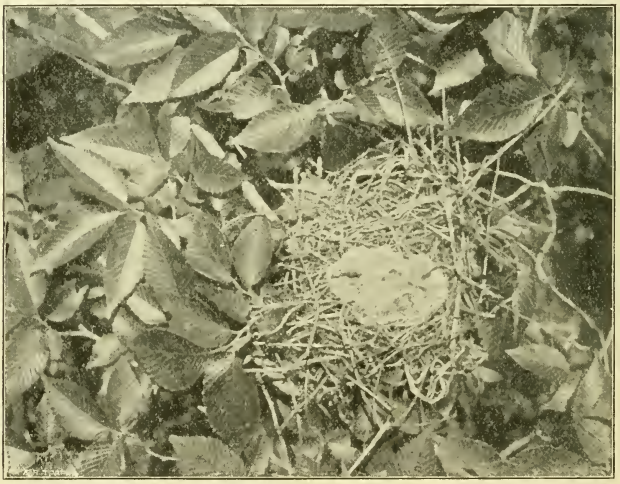
SINCE the beginnings of the science-art of photography the photographic artists have striven not only to "hold the mirror up to nature," but to fix imperishable pictures of the image reflected there. Of late years wonderful things have been accomplished. The bird woman has defied all the discomforts of hours of waiting in the forest depths to bring home pictures of the fledglings in the nest; Mr. Chapman has solved the mystery of the flamingo city, and proved, by photographs, the truth of his statements; Mr. Dugmore has caught bird and beast in intimate home life and shown them to us as they are; J. Horace McFarland, with loving care, has made us also "acquainted with the trees"; Mabel Osgood Wright has imprisoned in books the beds of wild flowers and ferns the botanist loves and dreams of.

In Kansas, also, the beauties of nature have appealed to the amateur photographer and much fine work has resulted, such as the illustrations of Doctor Quayle's nature books from pictures taken by Professor Parmenter and Almina Woods. So far as I know, no one has surpassed the McColms, as they present to us flowers, birds, animals and landscapes in Kansas.

For the artistic perfection of their work various causes are assigned. One says they know exactly how much time to give to an exposure; another says they have a fine perception of perspective; Miss McColm herself ascribes much of their success to a careful attention to detail. All these are doubtless true; but also is it true, as one of their Eastern publishers suggests: "They have, besides mechanical skill, the soul of the artist, and this they put into their pictures."

Some years ago I found in a floral magazine a page of Kansas wild-flower pictures, by G. E. McColm. The reproduction was not good, but something of artistic truthfulness, as well as the fact that they were correctly named, attracted my attention. Later, illustrated articles appeared in the Kansas City *Star* by the same author. Again the work of reproduction was poorly done, but I was much interested. Last winter I found in the *Club Member* a beautiful print, "Along the Wakarusa." This was signed "Viola McColm, Bucklin, Kan." Now, having found "the woman in the case," I

hesitated no longer, but sent a letter asking for unmounted photographs for Christmas gifts to friends. A prompt response came. with a package of these wonderful pictures to choose from. They were so singularly exact in detail, so clear and sharp in outline, and, withal, so beautiful, that I at once wished their merit might be brought to the attention of the Academy of Science, as the highest expression yet reached in our state of the photographic art beautiful. Miss McColm kindly consenting to furnish me with specimens and a few notes of their work, I am therefore enabled to have the honor of presenting them to you to-day.

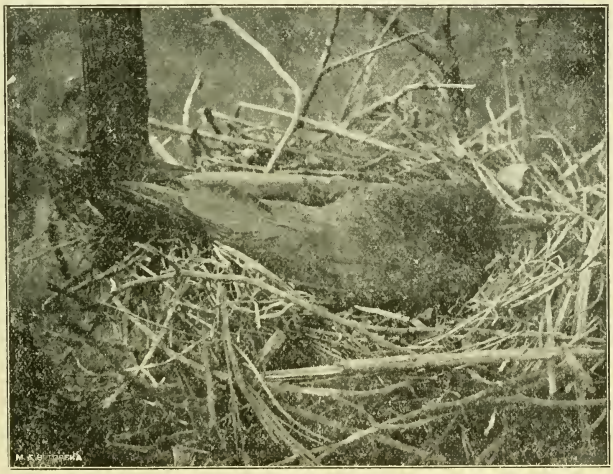


YOUNG MOURNING-DOVES.

Wishing to make a collection of pictures of out-of-door subjects, Miss McColm and her brother purchased a camera in 1899. So ignorant were they of photographic art that they supposed success in negative making depended wholly upon development. A few plates were exposed in Topeka on a dull November day, immediately after the purchase of the camera. They were taken to a photographer to be developed, as they took their first lesson in development. "All were badly undertimed exposures; so we had only spoiled plates instead of negatives," she says. Aside from this one lesson, all their knowledge of picture making has been gained from

books and from personal experience, and they do all their own finishing.

They were led to photograph nature subjects from a love for nature, and as they worked they found more and more to interest them, and the desire grew to know more of the things they pictured.

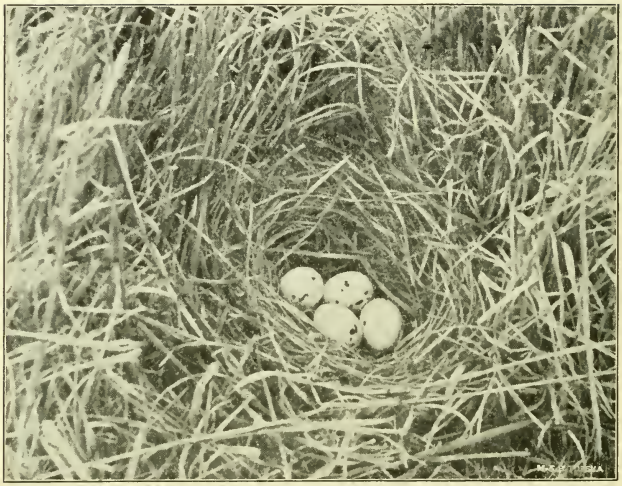


CROW, SITTING.

From Miss McColm's "Notes by the Way," I quote: "A still, cloudy day is the ideal one for photographing nature subjects. But we are not often favored with such conditions—especially in western Kansas.

"In photographing flowers, where they grow, it is desirable to be able to use a small diaphragm, and give time exposure, so as to have a good depth of focus and plenty of detail. From a negative possessing these qualities one may make good bromid enlargements.

"Sometimes just at sunrise or sunset it is calm, so one may give time exposure on flowers, and with the soft light obtain very beautiful results. Often, however, the wind blows continuously, and one must be content with a rapid snap-shot in the bright sunlight. When the wind does not interfere, an umbrella is useful to soften the light, when taking nature subjects near the middle of a bright ay.



NEST OF MEADOW-LARK.

"Orthochromatic or isochromatic plates, when they can be obtained fresh, are preferred for floral or landscape work, because they give better color values.

"In photographing an adult bird on the nest, the camera may be focused on the nest and everything made ready for the exposure; then one may go some distance away and, when the bird returns, take the picture by pulling a string attached to the shutter.

"In all our experience in bird photography the Yellow-billed cuckoo is the only one that has destroyed eggs because of our intrusion."

GAGINGS OF SEWAGE FLOW AT LAWRENCE, KAN.

By W. C. Hoad and A. H. Mann, University of Kansas, Lawrence.

THE following is a report of research work undertaken by Mr. A. H. Mann, an engineering senior at the University of Kansas, the work being done under the direction of Prof. W. C. Hoad. The report is written by Mr. Mann.

Very little investigation of the actual rates of flow of sewage in cities and towns has been made where this flow was observed continuously and for a considerable period. With the exception of one set of gagings made on two main sewers in Des Moines, Iowa, the writer was unable to find any record showing that gagings have been made in this manner and on a large amount of sewers.

These gagings at Des Moines were made by J. A. Moore and W. J. Thomas, class of 1895, Iowa Agricultural College. Two main sewers were gaged continuously for fifteen days.

The gagings at Lawrence were made in order to obtain a record of the continuous flow of sewage from a purely residence district and for a considerable length of time.

The conditions at Lawrence are especially favorable for this work, as the city has separate systems of sewerage, and all the sanitary sewers empty into the same outflow sewer. Another advantage for getting a record of the flow of house sewage is the fact that there are few factories in Lawrence, and these are near the river and have private sewers.

There are about 17.9 miles of sewers in Lawrence, ranging in sizes from eight inches to twenty-one inches in diameter.

Gagings were made on the main outflow sewer at the intersection of Pennsylvania and Henry streets, this place being chosen because the entire sanitary sewage of the city passes that point. Continuous gagings were made for thirty days.

Gagings were also made on the main sewer at the intersection of Quincy and Connecticut streets, so that the flow from the purely residential district could be studied. These gagings extended over a period of thirty-eight days, beginning a short time before and continuing during the same time as those on the main outflow sewer. The gagings were made during the months of March and April, 1906, and the rainfall was about the average for this section of the country. At times of heavy rains a large amount of rain-water reaches the sewers directly through manhole and flush-

tank sewers and from house roofs, as is plainly shown by the rapid rise in the flow-diagram curves whenever it rained while the gagings were being taken. As the main outflow sewer empties into the Kaw river below the surface of the water, it was necessary to make the gagings in manholes. The apparatus used consisted of a right-angled triangular weir placed in the sewer, and a device for continuously recording the head of the water above the weir. The recording device was placed three feet from the weir, on the upstream side. The weirs were gaged in the hydraulic laboratory of the Kansas State University, with the water admitted in a manner similar to the way that it would reach the weirs in the sewers. The weirs were placed in the sewer where that leaves the manhole. A bicycle tube was used for packing around the weirs. When in place the bicycle tube was pumped full of air and made a water tight joint. The apparatus that recorded the height of the water consisted of a cylinder about four inches in diameter and twelve inches long, which was run by a clock. A pencil fastened to a rod extending up from the float recorded the height of the water over the weir on a record sheet placed around the cylinder.

The records were then reproduced on drawing paper by tracing them over carbon paper, so that each day's curve was superimposed on all preceding curves. From the entire series of plotted curves a single curve representing a general average could be inferred graphically. Individual curves show a number of small fluctuations, probably due to the emptying of flush-tanks. Some large fluctuations, due to a weekly emptying of a large swimming-pool, showed both the accuracy and sensitiveness of the recording apparatus. The following results were obtained:

The maximum rate of flow for the main outflow sewer and the Connecticut Street sewer were, respectively, 206 gallons and 226 gallons per capita per day, but as these were during heavy rains, they do not mean much in this work.

The maximum dry-weather rate of flow for the main outflow sewer was about 130 gallons per capita per day, and occurred between nine and ten o'clock A. M. The minimum rate of flow for the main outflow sewer was 56 gallons per capita per day, and occurred at about four o'clock A. M.

The maximum dry-weather rate of flow for the Connecticut Street sewer was about 150 gallons per capita per day, and occurred between eight and nine o'clock A. M.

The average rate of flow for the Connecticut Street sewer was 82 gallons per capita per day. The average rate of flow for the main outflow sewer was 85 gallons per capita per day.

The number of people using the sewers was obtained by counting the houses on the blocks reached by sewers and multiplying by six. This gives 8400 as the number of people using the sewers. Comparison was made with the amount of water used for domestic purposes, which was estimated at 107 gallons per capita per day, and which the writer believes is rather high, because some of the data used to get these figures seemed somewhat indefinite.

If 85 gallons be taken as the number of gallons of sewage per capita per day, and 107 gallons per capita per day taken as the amount of water used, the sewage flow is found to be about eighty per cent. of the water consumption.

THE ACCURACY OF A MODERN BALANCE AND SET OF WEIGHTS.

By H. I. Woods and Alice K. McFarland, Washburn College, Topeka.

IT would seem to be a matter of some interest to know just what may be expected of a good precision balance of modern construction, bought in open market, without any special requirements having been imposed on the maker or dealer. The construction, as regards material and workmanship, perhaps may be judged to some extent by general appearances to a critical observer, and by facility of adjustment and smoothness of operation. The excellence of the instrument in the precise determination of weights, depending largely on the equality of lengths of arms and smoothness of the sensibility curve, can be determined only by careful tests.

The balance chosen for the tests here reported is by Paul Bunge, Hamburg, and is of the type described in his catalogue as number "0." It is also described in Watson's Physics (pp. 109, 110). The length of the beam is nominally 13 cm., and is of the short-arm, high-stayed triangle form. The rider scale, also 13 cm. long, extends along the entire front of the beam, and is numbered from 0 to 10, each tenth of the length being subdivided into 10 parts, or 100 in all. The rider weighs nominally 5 mg., and is to be at the "0," beam horizontal and no load. The pointer is long, 25.5 cm. from the central knife edge.

As ordinarily used the balance has the usual sensitiveness of $\frac{1}{10}$ mg. but a delicacy of $\frac{1}{100}$ mg. may be readily secured by placing a small cylindrical weight on the top of an arm extending vertically upward back of the center of the beam. The swings are then read by a microscope extending through the front of the case at an angle of forty-five degrees and focused on a small ivory scale attached to the pointer about 4 cm. from its lower end. This scale is 10 mm. long and is divided into 100 parts, microscopic figures being placed at each tenth division. This fine scale, in addition to its use in very precise weighings with the fine adjustment, enables one to make more accurate determinations with the ordinary $\frac{1}{10}$ mg. sensitiveness than is possible by reading the swings in the ordinary way on the coarse scale. The vibration time being, of course, the same, readings may be made with almost as great facility through the microscope as on the coarse scale.

The testing of the balance and weights has thus far consisted of the following determinations:

1. The testing of the weights by the Bureau of Standards.
2. The sensibility curve.
3. The values of certain weights from laboratory sets, both for purposes of calibration and to determine how closely values may be repeated.
4. The ratio of the arms.

The details of the above determinations are as follows:

1. *Testing of the Weights.*—The weights were also by Bunge, supplied with the balance, and of the usual type. They were sent to the Bureau of Standards for comparison with the United States standards. The following is taken direct from the certificate of the bureau:

"The weights designated below have been compared with the United States standards and have the following corrections:

Designation.	*Correction.*	*Designation.*	*Correction.*
100 grams	−0.4 mg.	500 mg	−0.015 mg.
50 "	−0.5 "	200 "	−0.034 "
20 "	−0.32 "	100^1 "	−0.068 "
10^1 "	−0.22 "	100^2 "	−0.034 "
10^2 "	−0.11 "	50 "	+0.070 "
5 "	−0.31 "	20 "	−0.013 "
2^1 "	−0.12 "	10^1 "	−0.027 "
2^2 "	−0.09 "	10^2 "	+0.012 "
1 "	−0.00 "	5^1 " rider	+0 076 "
		5^2 " "	+0.080 "

"A (+) correction means that the weight is heavier than the nominal value; a (—) correction that it is lighter by the amount indicated. When applied to the nominal value of a weight, the correction will give its mass referred to the international kilogram."

2. *Sensibility Curve.*—Readings for the sensibility curve were made in the usual way, using loads of even numbers of grams from 0 to 200. The microscopic scale was used, sensibility being taken as the number of divisions displacement for one mg. additional load. In the tabulation of results, "L" indicates the load; "S," divisions displacement per mg.; "M," means of five preceding values of "S." The values of "S" are the means of independent determinations by each of the authors of this paper. However, but one set of values was gotten by each observer, and it is probable that the irregularities are due quite as much, or more, to accidents of observation as to lack of uniform action of the balance. The curve traced from the values of "S" given shows a rather rapid drop from 0 to about 30, a tolerably uniform value slightly below 5 from 30 to about 130, and from this point to the maximum load

of 200 the gradually decreasing value indicates, it would seem quite clearly, the lowering of the centroid by the flexure of the beam under the increasing load. Perhaps the lowering of the values from 0 to 30 may be explained by a straightening out of the stays of the beam, or at least a drawing taut. It is quite likely that, owing to the form of the beam already mentioned, that of a triangle, the knife edges might be drawn slightly out of line with no load on the beam. After this the beam remains straight to about 130 gms. load, when it begins to bend slightly under the increased strain. Such an explanation would account for the three parts of the curve which appear rather marked. The data for the curve follow:

L.	*S.*	*M.*	*L.*	*S.*	*M.*	*L.*	*S.*	*M.*	*L.*	*S.*	*M.*
0	5.4		50	4.9		100	5.0		150	4.8	
2	5.2		52	5.0		102	4.9		152	4.8	
4	5.2		54	5.0		104	4.8		154	4.8	
6	5.2		56	5.0		106	4.9		156	4.8	
8	5.0	5.20	58	5.0	4.98	108	5.0	4.92	158	4.8	4.80
10	5.1		60	5.0		110	4.9		160	5.1	
12	5.1		62	4.9		112	5.0		162	4.9	
14	5.3		64	4.9		114	5.0		164	4.7	
16	5.1		66	4.9		116	4.9		166	5.0	
18	5.0	5.12	68	5.1	4.96	118	4.9	4.94	168	4.9	4.92
20	5.3		70	4.9		120	5.0		170	4.8	
22	5.1		72	4.8		122	4.9		172	4.8	
24	5.0		74	5.2		124	4.9		174	4.8	
26	5.1		76	4.9		126	5.0		176	4.7	
28	5.0	5.10	78	4.9	4.94	128	4.9	4.94	178	4.7	4.76
30	4.8		80	4.9		130	4.9		180	4.7	
32	5.2		82	4.9		132	4.9		182	4.6	
34	5.0		84	5.0		134	4.9		184	4.6	
36	4.9		86	4.7		136	4.8		186	4.6	
38	4.9	4.96	88	5.0	4.90	138	4.8	4.86	188	4.8	4.66
40	5.0		90	4.9		140	4.8		190	4.7	
42	5.0		92	4.9		142	4.8		192	4.7	
44	5.2		94	5.0		144	4.8		194	4.7	
46	4.9		96	4.9		146	4.8		196	4.7	
48	5.1	5.04	98	5.0	4.94	148	4.8	4.80	198	4.7	4.70
50	4.9		100	5.0		150	4.8		200	4.7	

3. *Values of Laboratory Weights.*—The weights were as follows: 1, 20, 50 and 100 gms.; combinations were also made to give 120, 150 and 170 gms. The headings of the columns explain the data.

Nominal values.	Determined weights.		Differences.
	W.	McF.	
gm.	*gm.*	*gm.*	*mg.*
1	0.99984	0.99983	0.01
20	20.00065	20.00061	0.04
50	49.99854	49.99852	0.02
100	99.99991	99.99992	0.01
120	120.00051	120.00048	0.03
150	149.99835	149.99842	0.07
170	169.99907	169.99903	0.04.

Each weight given is the means of weighings right and left—not the square root of the product. But one determination of each weight was made by each observer. The adjustment of the balance was for the lower sensitiveness of $\frac{1}{10}$ mg. It was planned to make determinations for a sensitiveness of $\frac{1}{100}$ also, but lack of time prevented. All values have been carried out at least one place further than shown in the above figures.

4. *Ratio of the Arms.*—The ratio of the arms has been computed from the $\frac{1}{4}$ values from 20 to 170, with the results given:

Load.	Ratio of arms, L/R.	
	W.	McF.
20	0.999995	0.999997
50	7	7
100	6	7
120	8	8
150	5	8
170	8	8
	0.9999965	0.9999975

Mean value of L/R, 0.999997.

Further determinations are desired, especially for the higher sensitiveness, no values of which are given, and but few of which have been secured.

The weighings were all made without any precautions to secure dryness of the air in the balance case.

CHANGE IN THE CLIMATE OF KANSAS.

By F. H. Snow, University of Kansas, Lawrence.

IN reiteration of his statements before the congressional committee regarding the subject of a change of climate in the region which includes the states of Kansas and Nebraska, Dr. Willis L. Moore, chief of the United States Weather Bureau, has issued a pamphlet. Among these statements I note the following: "We find, right in the arid regions, that during a long period of observations, thirty, forty or fifty years, the average rainfall of the first ten years is precisely the same as the average of the last." Yet, in the tabular statement which concludes Doctor Moore's pamphlet, only the last thirty years are included, although the records of three of the stations named cover respectively forty-eight, thirty-nine and forty-one years. I submit that a fair comparison of facts bearing upon so important a subject as the change of climate should include the entire period of observation.

My own records at Lawrence cover a period of thirty-nine years, from 1868 to 1906. During the first ten years of this period, from 1868 to 1877, the average annual rainfall was 34.91 inches; during the last ten years, 1897 to 1906, it was 38.16 inches, giving an increase of 3.25 inches per annum. But a more satisfactory method of comparison is to divide the entire period of observation into two equal parts. The total rainfall at Lawrence for the first half of the thirty-nine years, from January 1, 1868, to July 1, 1887, was 672.81 inches, while during the second half of the period the total was 743.67 inches, giving an increase of 70.86 inches in the total precipitation. This makes the average annual rainfall for the first half of the period 34.50 inches, while for the second half it is 38.14 inches, an increase of 3.64 inches, or more than ten per cent. And this is the result, although the rainfall at Lawrence for the year 1906 was only 28.50 inches—more than 8 inches below the average for the thirty-eight preceding years. This notable deficiency for 1906 occurred in the eastern portion of the region west of the ninety-fifth meridian, in which region Doctor Moore says that the rainfall for 1906 was excessive in all that vast stretch of territory.

Notwithstanding the facts brought out by my own observations, which have been regularly forwarded to the chief of the Weather Bureau, at Washington, at the end of each month and year, Doctor Moore states that "the rainfall has neither increased nor diminished

by amounts worthy of consideration." This statement, however, may be considered correct with regard to the western third of Kansas and Nebraska, as shown by the records of Dodge and North Platte; but it is not correct in regard to the eastern and central portions of those states, where the breaking and cultivation of the soil upon a large scale and the great increase of forestation have combined to produce conditions favorable to an increased rainfall. In the western portions of Kansas and Nebraska the conditions are practically the same to-day as they were in the eastern portions of those states when settlement first began.

There never has been a better opportunity to test the question of the effect of the sudden human occupation of an agricultural region upon climatic conditions than has been afforded in eastern and central Kansas and Nebraska during the last fifty years. Three millions of people now occupy this agricultural region, where fifty years ago the entire area was unplowed prairie. When I came to Kansas, in 1866, to begin my life-work as a member of the faculty of the State University, the only timber consisted of a narrow belt along each stream; and during the late autumn and winter I often counted at night as many as fifty to seventy simultaneous prairie-fires from my study windows in the University buildings, on the summit of Mount Oread. At that time by daylight, from the same point of view, every house in the city of Lawrence was plainly visible from foundation to roof, while at the present time the buildings, although greatly increased in number, are completely concealed from view by the foliage of the multitudinous shade-trees. The surrounding country also has been so changed in appearance by the growth of trees under human direction as no longer to bear the remotest resemblance to the original prairie surface.

Not only has the rainfall increased, but the atmospheric humidity has also increased. The average relative humidity for the first half of the period of my observations was 68.76 per cent., while during the second half it had risen to 73.21 per cent. When I came to Kansas, in 1866, and for several years thereafter, no dew was deposited upon the grass until toward morning, and one could walk through the grass at any time before midnight without wetting one's shoes. Of late years, the dew generally begins to be deposited on the grass before the twilight is over, as in the Eastern states, thus corroborating the observed increase in the atmospheric humidity.

In regard to the velocity of the wind, Doctor Moore, in his hearing before the congressional committee, stated that he was quite

certain that there had been no change in the general high velocity, for an altitude of 50, 60 or 100 feet, although the trees would restrict the velocity of the wind near the ground. In his pamphlet just issued he states that "an examination of the wind records in Kansas and Nebraska show that the last fifteen years have not been quite so windy as the fifteen years previous, but that it is not safe to assume that a permanent decrease in the wind velocity has taken place." My own records of the wind velocity began on July 1, 1872, when an excellent recording apparatus was installed upon the roof of the north dome of the main building of the University of Kansas, 105 feet above the ground, the ground itself being 250 feet above the broad valley of the Kansas river. This apparatus has been carefully kept in order under my personal direction during the entire $34\frac{1}{2}$ years, and its results have been compared with, and corroborated by, those of a standard anemometer of the signal service pattern, which for fifteen years was in operation at the same elevation. If we adopt the method of comparison used by Doctor Moore in his rainfall statistics, and divide the thirty-four years into ten-year sections, we have the following results:

The average annual wind run of the first ten years (1873–'82) was 138,052 miles; of the second ten years (1883–'92), 131,040 miles; of the third ten years (1893–1902), 122,012 miles; of the last four years (1902–'06), 100,212 miles. But, as stated in regard to the rainfall, it seems to be a more satisfactory method of comparison to divide the entire period into two equal parts. By this method we find the average annual wind run of the first seventeen complete years (1873–'89), to be 134,389 miles, and of the second seventeen years (1890–1906), 119,252 miles. This gives an average reduction of 15,137 miles per annum for the second half of our period of observation as compared with the first half. Stated in another way, the average velocity of the wind for the first seventeen years was 15.34 miles an hour, while for the second seventeen years it was only 13.61 miles an hour, giving a reduction of nearly twelve per cent.

It thus appears that the observations of nearly forty years, made continuously by and under the direction of the writer, indicate a gradual change in the climate at Lawrence, Kan. And as this locality presents a typical illustration of the climatic conditions of eastern Kansas, it is safe to infer that the same changes are taking place over the entire region of which it forms a part. The rainfall and atmospheric humidity have increased, and the wind velocity has decreased. The change in the rainfall and wind

velocity has been in each case more than ten per cent., while the increase in the atmospheric humidity has been more than six per cent. And these results are based not "upon the recollections of the oldest inhabitants." but upon the faithful records of actual observations.

VI.

APPENDIX.

Accessions to the Academy Library, 1905 and 1906.
Advertisement of Volumes Issued by the Academy.
Index to Volume XX, Part II (1906).

APPENDIX.

ACCESSIONS TO THE LIBRARY.

JANUARY 1, 1905, TO DECEMBER 31, 1906.

ALABAMA.

Map of Coal-fields.

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A provisional catalogue, compiled under direction of Prof. F. B. Dains, will soon be issued, showing the scientific resources of libraries in the state-house and in Washburn College. This will be printed under direction of the state librarian, and cannot fail to be a great help to scientific workers in this vicinity.

The usual announcement of our next annual meeting will be sent out some time in August, and all members are urged to communicate with the secretary if they have a choice as to the time of meeting or can give any suggestion that will contribute to the success of our next meeting, at Emporia. We ought to increase our membership, so as to include at least all Kansans who are interested in the progress of science. The nominal fee of membership is amply repaid by our annual volumes, and it rests with members to show how much these can be improved. Local branches of the Academy, with more frequent meetings and greater opportunity for discussion, might stimulate our work and widen its influence.

J. T. LOVEWELL.

TOPEKA, KAN., March, 1907.

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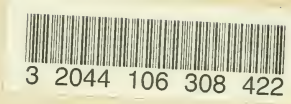
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